



# The American Journal of Surgery

PUBLISHED MONTHLY BY THE AMERICAN JOURNAL OF SURGERY, INC.

49 WEST 45TH STREET, NEW YORK, N. Y.

Editor: THURSTON SCOTT WELTON, M.D., F.A.C.S., NEW YORK

## EDITORIAL BOARD

DONALD C. BALFOUR, Rochester, Minn.; CARL BECK, Chicago; GEO. R. BRIGHTON, N.Y.; MEREDITH F. CAMPBELL, N.Y.; JAMES T. CASE, Chicago; ISIDORE COHN, N.O.; BRADLEY L. COLEY, N.Y.; FREDERICK A. COLLIER, Ann Arbor; GEORGE W. CRILE, Clev.; ELLIOTT C. CUTLER, Boston; ROBERT V. DAY, Los Angeles; CHARLES A. ELSBERG, N.Y.; HERBERT C. FETT, Brooklyn; C. R. G. FORRESTER, Chicago; H. DAWSON FURNISS, N.Y.; JOHN H. GIBBON, Phila.; EMIL GOETSCH, Brooklyn; CHARLES A. GORDON, Brooklyn; DONALD GUTHRIE, Sayre, Pa.; A. E. HERTZLER, Kansas City; LOUIS J. HIRSCHMAN, Detroit; J. M. HITZROT, N.Y.; FREDERICK C. HOLDEN, N.Y.; EMILE F. HOLMAN, San Francisco; J. A. HYAMS, N.Y.; R. H. JACKSON, Madison; JOHN E. JENNINGS, Brooklyn; W. L. KELLER, Washington; HOWARD A. KELLY, Baltimore; T. J. KIRWIN, N.Y.; ARTHUR KRIDA, N.Y.; A. V. S. LAMBERT, N.Y.; MAURICE LENZ, N.Y.; H. H. M. LYLE, N.Y.; JEROME M. LYNCH, N.Y.; URBAN MAES, N.O.; HARRISON S. MARTLAND, Newark, N.J.; RUDOLPH MATAS, N.O.; ROY D. MCCLURE, Detroit; H. C. NAFFZIGER, San Francisco; CLARENCE R. O'CROWLEY, Newark, N.J.; LOUIS E. PHANEUF, Boston; EUGENE H. POOL, N.Y.; DOUGLAS QUICK, N.Y.; N. P. RATHBUN, Brooklyn; HUBERT A. ROYSTER, Raleigh; HENRY S. RUTH, Phila.; A. C. SCOTT, Temple, Tex.; M. G. SEELIG, St. Louis; J. BENTLEY SQUIER, N.Y.; H. J. STANDER, N.Y.; GEORGE W. SWIFT, Seattle; H. L. UPDEGRAFF, Los Angeles; GRANT E. WARD, Balt.; J. H. WOOLSEY, San Francisco.

Foreign Collaborators—GREAT BRITAIN—J. H. WATSON, Burnley. FRANCE—G. JEANNENEY, Bordeaux. ITALY—R. BASTIANELLI, Rome.

NEW SERIES, VOLUME XXXVI

APRIL TO JUNE

1937

THE AMERICAN JOURNAL OF SURGERY, INC., PUBLISHERS  
NEW YORK MCMXXXVII



COPYRIGHT, 1937  
BY THE AMERICAN JOURNAL OF SURGERY, INC.  
*All Rights Reserved*

*Printed in the United States of America*

# CONTENTS OF NEW SERIES, VOLUME XXXVI

## ORIGINAL ARTICLES

|   |  |     |
|---|--|-----|
| Wounds and Their Complications . . . . .                | <i>W. Wayne Babcock</i> . . . . .  | 3   |
| Treatment of Open Infected Wounds . . . . .             | <i>Henry S. F. Cooper</i> . . . . .  | 11  |
| Michel Clips in Skin Coaptation . . . . .               | <i>Thurston Welton</i> . . . . .   | 14  |
| Bedsore (Decubitus) . . . . .                           | <i>Manuel G. Spiesman</i> . . . . .  | 17  |
| Gas Gangrene . . . . .                                  | <i>Phil Thorek</i> . . . . .   | 22  |
| Blood Transfusion . . . . .                             | <i>John M. Scannell</i> . . . . .  | 26  |
| Intravenous Infusions . . . . .                         | <i>Henry C. Falk</i> . . . . .   | 31  |
| Acute Lymphangitis . . . . .                            | <i>William A. Steel</i> . . . . .  | 37  |
| Human Bites . . . . .                                   | <i>Edward P. Dunn</i> . . . . .  | 44  |
| New Method for Transfer of Full-thickness Skin:         |  |     |
| Grille Graft . . . . .                                  | <i>G. Frank Sammis</i> . . . . .   | 46  |
| Burns . . . . .   | <i>Walter A. Coakley</i> . . . . .   | 50  |
| Treatment of Burns with Brilliant Green . . . . .       | <i>Joseph K. Narat</i> . . . . .   | 54  |
| Infections of Head . . . . .                            | <i>Reynold Erskine Church</i> . . . . .  | 57  |
| Malignant Tumors of Head . . . . .                      | <i>George A. Wyeth</i> . . . . .   | 63  |
| Angiomata of Skeletal Muscle . . . . .                  | { <i>H. B. Thomas</i> . . . . .<br><i>F. W. Hark</i> . . . . . }   | 69  |
| Infections of Neck . . . . .                            | <i>Denver M. Vickers</i> . . . . .   | 73  |
| Fractures of Nose . . . . .                             | <i>Joseph D. Kelly</i> . . . . .   | 77  |
| Fractures of Mandible and Maxilla . . . . .             | <i>Fred Squier Dunn</i> . . . . .  | 83  |
| Facial Scars . . . . .                                  | <i>Claire L. Strath</i> . . . . .  | 88  |
| Concealment of Scars . . . . .                          | <i>Joseph A. Tamerin</i> . . . . .   | 91  |
| Styes . . . . .   | <i>Edward J. Bassen</i> . . . . .  | 93  |
| Cinders and Splinters . . . . .                         | <i>Howard L. Updegraff</i> . . . . .   | 94  |
| Foreign Bodies in External Auditory Canal . . . . .     | <i>Harry Rosenwasser</i> . . . . .   | 96  |
| Incisions of Drum Membrane in Otitis Media . . . . .    | <i>Joseph G. Druss</i> . . . . .   | 102 |
| Treatment of Boils and Carbuncles . . . . .             | <i>Donald Gordon</i> . . . . .   | 107 |
| Furuncle of Upper Lip . . . . .                         | <i>Gerald H. Pratt</i> . . . . .   | 118 |
| Salivary Fistula . . . . .                              | <i>Dean Curtis</i> . . . . .   | 122 |
| Acute Pyogenic Parotiditis . . . . .                    | <i>John Henderson</i> . . . . .  | 125 |
| Wens . . . . .  | <i>Frank N. Dealy</i> . . . . .  | 132 |
| Moles, Warts and Keloids . . . . .                      | <i>Joseph L. Morse</i> . . . . .   | 137 |
| Benign Tumors of Back . . . . .                         | <i>Richard J. Weiskittel</i> . . . . .   | 145 |
| Hemorrhage Following Tonsillectomy . . . . .            | <i>Merrin C. Myerson</i> . . . . .   | 151 |
| Peritonsillar Abscess . . . . .                         | <i>Charles Reed Weeth</i> . . . . .  | 159 |
| Acute Retention of Urine . . . . .                      | { <i>Clarence G. Bandler</i> . . . . .<br><i>Arthur H. Milbert</i> . . . . . }                                   | 162 |
| Circumcision: Simplified Anatomical Technique . . . . . | <i>Richard Torpin</i> . . . . .  | 172 |
| Phymosis and Paraphymosis: Circumcision; Dor-           | { <i>Edgar G. Ballenger</i> . . . . .<br><i>Omar F. Elder</i> . . . . .<br><i>Harold P. McDonald</i> . . . . . } | 174 |
| sal Slit; Constriction of Male Meatus . . . . .         |  |     |
| Urethral Caruncle . . . . .                             | <i>Edward L. Kickham</i> . . . . .   | 178 |
| Treatment of Specific Urethritis—New Modality . . . . . | <i>Alvin C. Drummond</i> . . . . .   | 180 |
| Diagnosis and Treatment of Stricture of Male            |  |     |
| Urethra . . . . .                                       | <i>Joseph A. Hyams</i> . . . . .   | 189 |

|   |   |     |
|---|---|-----|
| Removal of Foreign Bodies from Urethra and Bladder . . . . .                  | Howard S. Jeck . . . . .  | 197 |
| Hydrocele and Varicocele: Operative and Injection Treatment . . . . .         | Lloyd B. Greene . . . . .   | 204 |
| Vas Deferens: Operative Treatment . . . . .                                   | Simon A. Beisler . . . . .  | 213 |
| Office Treatment of Bartholin's Gland Abscess or Cyst . . . . .               | Albert Mathieu . . . . .  | 219 |
| Imperforate Hymen . . . . .   | Maurice O. Belson . . . . .   | 221 |
| Biopsy of Uterine Cervix . . . . .  | Louis E. Phaneuf . . . . .  | 226 |
| Application of Radium in Carcinoma of Uterine Cervix . . . . .                | Frederick Emil Neef . . . . .   | 231 |
| Pathology and Office Treatment of Chronic Endocervicitis . . . . .            | Harvey Burleson Matthews . . . . .  | 233 |
| Cervical Polyp . . . . .  | Roy J. Heffernan . . . . .  | 239 |
| Congenital Abnormalities of Rectum . . . . .                                  | { Jerome Moreley Lynch . . . . . }<br>{ G. Johnson Hamilton . . . . . }                             | 240 |
| Fissure-in-Ano . . . . .  | Edward Levy . . . . .   | 244 |
| Cryptitis . . . . .   | E. Rapoport . . . . .   | 249 |
| Hemorrhoids . . . . .   | C. Naunton Morgan . . . . .   | 252 |
| Injection Treatment of Internal Hemorrhoids . . . . .                         | Vincent Hurley . . . . .  | 259 |
| Pruritis Ani . . . . .  | Max P. Cowett . . . . .   | 262 |
| Foreign Bodies in Rectum . . . . .  | Jerome Wagner . . . . .   | 266 |
| Pilonidal Cysts: Excision and Primary Suture in Ambulatory Patients . . . . . | { L. K. Ferguson . . . . . }<br>{ Paul M. Mecray . . . . . }  | 270 |
| Ischiorectal Abscess . . . . .  | S. Judd Bochner . . . . .   | 279 |
| Rupture of Muscles and Tendons . . . . .                                      | Joseph L. DeCourcy . . . . .  | 283 |
| Plaster-of-Paris . . . . .  | Herbert C. Fett . . . . .   | 288 |
| Use of Adhesive in Orthopedic Practice . . . . .                              | H. H. Wescott . . . . .   | 290 |
| Use of Unpadded Plaster in Treatment of Fractures . . . . .                   | Charles B. Mabry . . . . .  | 292 |
| Minor Surgery of Spine . . . . .  | Robert L. Preston . . . . .   | 298 |
| Fractures of Coccyx and Coccygodynia . . . . .                                | John C. McCauley . . . . .  | 303 |
| Fractures of Ribs . . . . .   | Lester Breidenbach . . . . .  | 308 |
| Pathology and Treatment of Ganglion . . . . .                                 | { Ralph H. De Orsay . . . . . }<br>{ Paul M. Mecray . . . . . }<br>{ L. Kraeer Ferguson . . . . . } | 313 |
| Colles's Fracture . . . . .   | Andrew R. MacAusland . . . . .  | 320 |
| First Aid Treatment of Fracture of Femur and Hip . . . . .                    | John H. Mulbolland . . . . .  | 323 |
| Office Surgical Treatment of Injuries of the Knee . . . . .                   | Robert M. Toll . . . . .  | 328 |
| Treatment of Hallux Valgus (Bunion) . . . . .                                 | W. P. Armstrong, Jr. . . . .  | 332 |
| Treatment of Congenital Talipes Equinovarus (Clubfoot) . . . . .              | James Graham . . . . .  | 339 |
| Ingrown Toe-nail . . . . .  | J. J. Kirschenmann . . . . .  | 349 |
| Hammer-toe and Claw Foot . . . . .  | Kenneth H. Schnepp . . . . .  | 351 |
| Simple Treatment for Puncture Wounds . . . . .                                | E. G. Festerling . . . . .  | 360 |
| Paronychia . . . . .  | G. Mason Astley . . . . .   | 362 |
| Felon (Whitlow) . . . . .   | James Norman Coombs . . . . .   | 366 |
| Frost-bite: Treatment by Passive Vascular Exercise . . . . .                  | Hugh L. Murphy . . . . .  | 370 |

|  |  |     |
|--|--|-----|
| Hand Infections: Office Treatment . . . . .  | <i>Alfred H. Iason</i> . . . . .   | 376 |
| Removal of Fish Hook Embedded in Finger . . . . .  | <i>Charles C. Murphy</i> . . . . .   | 384 |
| Polydactylism . . . . .  | <i>Horace E. Turner</i> . . . . .  | 385 |
| Treatment of Varicose Veins and Ulcers . . . . .   | <i>Robert F. Barber</i> . . . . .  | 386 |
| Clinical Comparison of Sclerosing Solutions in<br>Injection Treatment of Varicose Veins . . . . .                  | <i>Adolph A. Schmier</i> . . . . .   | 389 |
| Ambulatory Saphenous Ligation . . . . .  | { <i>Stuart Z. Hawkes</i> . . . . .<br><i>Irving P. Borsber</i> . . . . .}   | 398 |
| Artificial Pneumothorax . . . . .  | { <i>Edgar Mayer</i> . . . . .<br><i>Martin Dworkin</i> . . . . .}   | 403 |
| Useful Artificial Feeding Formula . . . . .  | <i>Gurn Stout</i> . . . . .  | 412 |
| Operating Room Signals . . . . .   | <i>Howard L. Updegraff</i> . . . . .   | 414 |
| Book Reviews . . . . .   |  | 416 |
| Maternal Mortality and Obstetric Conscience . . . . .  | <i>Charles A. Gordon</i> . . . . .   | 418 |
| Total Thyroidectomy in Angina Pectoris and Con-<br>gestive Failure . . . . .                                       | { <i>Morris Dinnerstein</i> . . . . .<br><i>Carnes Weeks</i> . . . . .<br><i>I. Ogden Woodruff</i> . . . . .<br><i>Albert R. Tilley</i> . . . . .} | 421 |
| The Truss in Relationship to Diagnosis and Injec-<br>tion Treatment of Inguinal Hernia . . . . .                   | { <i>Franklin I. Harris</i> . . . . .<br><i>Alfred S. White</i> . . . . .}   | 443 |
| Foreign Bodies in Tracheobronchial Tree . . . . .  | { <i>Morris S. Bender</i> . . . . .<br><i>Max L. Som</i> . . . . .}  | 462 |
| Insertion of Smith-Petersen Nail for Intracapsular<br>Fractures of Neck of Femur . . . . .                         | <i>J. Albert Key</i> . . . . .   | 466 |
| Local Application of Cod-liver Oil in Skin Ulcer-<br>ations . . . . .  | <i>Ervin Epstein</i> . . . . .   | 472 |
| Lymphosarcoma of Stomach: Clinical and Roent-<br>genological Aspects . . . . .                                     | { <i>S. D. Zaph</i> . . . . .<br><i>Harry A. Olin</i> . . . . .<br><i>J. D. Kirsbaum</i> . . . . .}  | 476 |
| Treatment of Abortion . . . . .  | <i>Morris Glass</i> . . . . .  | 487 |
| Hyperemesis Gravidarum . . . . .   | { <i>Fred. A. Kassebohm</i> . . . . .<br><i>Milton J. Schreiber</i> . . . . .}   | 491 |
| Helpful Drug in Treatment of Tuberculosis of<br>Urinary Bladder . . . . .  | <i>John T. Bate</i> . . . . .  | 500 |
| Morbidity and Mortality Following Operations on<br>Biliary Tract . . . . .   | { <i>Calvin M. Smyth, Jr.</i> . . . . .<br><i>James B. Mason</i> . . . . .}  | 505 |
| Chronic Painful Conditions Amenable to Relief by<br>Intraspinal (Subarachnoid) Injection of Alco-<br>hol . . . . . | <i>Elias Lincoln Stern</i> . . . . .   | 509 |
| Traumatic Injury of Abdomen with Extensive<br>Damage to Colon and Small Bowel . . . . .                            | <i>D. C. Donald</i> . . . . .  | 514 |
| Stab Wound of Heart, Right Ventricle . . . . .   | { <i>Walter D. Ludlum, Jr.</i> . . . . .<br><i>Abraham Katz</i> . . . . .}   | 520 |
| Mucocele of Appendix with Pseudomucinous<br>Degeneration . . . . .   | <i>C. Hiram Weaver</i> . . . . .   | 523 |
| Gastrojejunalocolic Fistula . . . . .  | <i>Adolph Von Prief Fardelmann</i> . . . . .   | 527 |
| Sympathectomy for Hirschsprung's Disease and<br>Polyposis . . . . .  | <i>Claude E. McCarty</i> . . . . .   | 531 |
| Combined Roengenotherapy and Ultra-short<br>Wave . . . . .   | { <i>Isidore Arons</i> . . . . .<br><i>Boris Sokoloff</i> . . . . .}   | 533 |

|   |   |     |
|---|---|-----|
| A New Instrument and Technique for Intestinal Anastomoses . . . . .                               | { <i>John R. O'Sullivan</i> . . . . .<br><i>Bernard A. O'Connor</i> . . . . .}                                      | 544 |
| Heater for Intravenous Solutions . . . . .  | <i>Joseph K. Narat</i> . . . . .  | 550 |
| Some Aids in Treatment of Compound Fractures . . . . .  | <i>Herman Charache</i> . . . . .  | 551 |
| Sketch of the Evolution of American Orthopedic Surgery . . . . .                                  | <i>Royal Whitman</i> . . . . .  | 553 |
| Chapter v. Fibroids (Third Installment) . . . . .   | <i>Henry C. Falk</i> . . . . .  | 558 |
| Dangers of Roentgenoscopy and Methods of Protection . . . . .                                     | { <i>Clyde A. Stevenson</i> . . . . .<br><i>Eugene T. Leddy</i> . . . . .<br><i>Arthur U. Desjardins</i> . . . . .} | 603 |
| Mammographic Recognition of Intracystic Papilloma of Breast . . . . .                             | { <i>N. Frederick Hicken</i> . . . . .<br><i>R. Russell Best</i> . . . . .<br><i>J. P. Tollman</i> . . . . .}       | 611 |
| Lynch's Simplification of Perineal Excision of Rectum . . . . .                                   | { <i>Jerome M. Lynch</i> . . . . .<br><i>G. Johnson Hamilton</i> . . . . .<br><i>R. W. McNealy</i> . . . . .}       | 618 |
| Simple Technique for Cecostomy . . . . .  | { <i>Manuel E. Lichtenstein</i> . . . . .<br><i>L. M. Boyers</i> . . . . .}   | 620 |
| Shock . . . . .   | <i>L. M. Boyers</i> . . . . .   | 623 |
| Rupture of Bladder and Urethra . . . . .  | <i>George F. Cabill</i> . . . . .   | 653 |
| Subacute Perforations of Peptic Ulcers . . . . .  | <i>Arthur M. Dickinson</i> . . . . .  | 663 |
| Inframural Gastrostomy . . . . .  | <i>A. L. Soresi</i> . . . . .   | 668 |
| Use of Pitressin for Control and Relief of Distention . . . . .                                   | <i>W. D. Frazier</i> . . . . .  | 672 |
| Malunited Fractures of Lower End of Humerus . . . . .   | <i>A. R. Shands</i> . . . . .   | 679 |
| Pulmonary Embolism . . . . .  | <i>Arthur Bowen</i> . . . . .   | 694 |
| Pregnancy in Rudimentary Horn of Bicornuate Uterus . . . . .                                      | <i>Sanford Kaminester</i> . . . . .   | 700 |
| Epigastric Hernia Causing Severe Symptoms . . . . .   | <i>M. R. Charlton</i> . . . . .   | 703 |
| Volvulus of Right Colon and Meckel's Diverticulum . . . . .                                       | <i>Adolph A. Walkling</i> . . . . .   | 705 |
| Acute Regional (Terminal) Ileitis . . . . .   | <i>Thomas J. Ryan</i> . . . . .   | 708 |
| Studies of the Natural History of Genitourinary Tumors. I: Primary Cancer of Ureter . . . . .     | <i>Judson B. Gilbert</i> . . . . .  | 711 |
| Hydronephrosis Due to Ball-valve Obstruction from Bullet Lying Free in Renal Pelvis . . . . .     | <i>James A. H. Magoun</i> . . . . .   | 717 |
| Plastic Restoration for Loss of All Fingers of Both Hands . . . . .                               | <i>S. L. Haas</i> . . . . .   | 720 |
| Blank Cartridge Cannon Shot Wound of Leg . . . . .  | <i>Herbert Willy Meyer</i> . . . . .  | 724 |
| Intestinal Prolapse through Enterostomy Following Rammstedt Operation . . . . .                   | <i>Joseph K. Narat</i> . . . . .  | 729 |
| Mechanical Holder for Retractors in Neurosurgery . . . . .  | <i>Wallace B. Hamby</i> . . . . .   | 732 |
| New Instrument for Intestinal Anastomosis . . . . .   | <i>Frank Glenn</i> . . . . .  | 734 |
| Device for Tightening Wire for Bone Fixation . . . . .  | <i>John A. Caldwell</i> . . . . .   | 736 |
| The Kut-Klamp: A New Surgical Instrument Which Simultaneously Cuts and Retains a Suture . . . . . | <i>David I. Solomon</i> . . . . .   | 737 |
| The Life and Times of Thomas Sydenham . . . . .   | <i>N. P. Ratbun</i> . . . . .   | 739 |
| Book Reviews . . . . .  |   | 745 |
| Practical Clinical Gynecology (Fourth Installment) . . . . .                                      | <i>Henry C. Falk</i> . . . . .  | 748 |

# The American Journal of Surgery

is the leading independent surgical Journal. It publishes many papers read before the outstanding Surgical Societies, but it is not "the official organ" of any organization. Every manuscript is selected by the editors, as worthy of publication—nothing is published because "it was read at the meeting."

Copyright, 1937, by THE AMERICAN JOURNAL OF SURGERY, INC.

NEW SERIES, VOL. XXXVI

APRIL, 1937

No. 1

## EDITORIAL BOARD

Editor:

THURSTON SCOTT WELTON

New York

|                      |                  |
|----------------------|------------------|
| D. C. Balfour        | Rochester, Minn. |
| Carl Beck            | Chicago          |
| Geo. R. Brighton     | New York         |
| Meredith F. Campbell | New York         |
| James T. Case        | Chicago          |
| Isidore Cohn         | New Orleans      |
| Bradley L. Coley     | New York         |
| F. A. Coller         | Ann Arbor        |
| George W. Crile      | Cleveland        |
| E. C. Cutler         | Boston           |
| R. V. Day            | Los Angeles      |
| Charles A. Elsberg   | New York         |
| Herbert C. Fett      | Brooklyn         |
| C. R. G. Forrester   | Chicago          |
| H. Dawson Furniss    | New York         |
| J. H. Gibbon         | Philadelphia     |
| Emil Goetsch         | Brooklyn         |
| Charles A. Gordon    | Brooklyn         |
| Donald Guthrie       | Sayre, Pa.       |
| A. E. Hertzler       | Kansas City      |
| Louis J. Hirschman   | Detroit          |
| James M. Hitzrot     | New York         |
| Frederick C. Holden  | New York         |
| Emile F. Holman      | San Francisco    |
| J. A. Hyams          | New York         |
| R. H. Jackson        | Madison          |
| John E. Jennings     | Brooklyn         |
| W. L. Keller         | Washington, D.C. |
| H. A. Kelly          | Baltimore        |
| T. J. Kirwin         | New York         |
| Arthur Krida         | New York         |
| A. V. S. Lambert     | New York         |
| Maurice Lenz         | New York         |
| H. H. M. Lyle        | New York         |
| Jerome M. Lynch      | New York         |
| Urban Maes           | New Orleans      |
| Harrison S. Martland | Newark           |
| Rudolph Matas        | New Orleans      |
| Roy D. McClure       | Detroit          |
| H. C. Naffziger      | San Francisco    |
| C. R. O'Crowley      | Newark           |
| Louis E. Phaneuf     | Boston           |
| Eugene H. Pool       | New York         |
| Douglas Quick        | New York         |
| N. P. Rathbun        | Brooklyn         |
| H. A. Royster        | Raleigh          |
| Henry S. Rurb        | Philadelphia     |
| A. C. Scott          | Temple           |
| M. G. Seelig         | St. Louis        |
| J. Bentley Squier    | New York         |
| H. J. Stander        | New York         |
| George W. Swift      | Seattle          |
| H. L. Updegraff      | Los Angeles      |
| Grant E. Ward        | Baltimore        |
| J. H. Woolsey        | San Francisco    |

## EDITORIAL

### MINOR AND OFFICE SURGERY

WHAT may be considered minor surgery and the point at which it becomes major, as well as what surgical conditions may properly and with safety be attempted in a physician's office, have been and still remain debatable topics. We have no wish to interject our opinions or line up with those on either side of the controversy.

We realize, however, that throughout the country and among many of our subscribers are men practicing in what are called rural or the "smaller places," as well as men in cities who do not devote all of their time to major surgery. These men, by no stretch of the imagination, can be classified as specialists in any branch of surgery. Part of their work must embrace the routine duties of the general practitioner. In addition, they must be prepared and able to handle those so-called minor surgical afflictions common to mankind. The urban center with its large, well equipped hospitals and clinics, staffed by all manner and degree of specialists, often are many miles away. The physician serving his community must stand on his own feet and know how to meet and handle the emergency, be it major or minor. If he would continue in that community he must know how to do many minor procedures for so-called minor surgical conditions.

Recently, Dr. Eugene H. Pool, Professor of Surgery, Cornell University Medical College, in an address before the New York Academy of Medicine, pointed out:

The treatment of the common injuries is touched but lightly in the medical school and at surgical meetings. The application of a bandage, the suturing of a wound, the care of local infections and the treatment of fractures and dislocations are relegated to secondary place in the efforts of the teacher of surgery. Yet modern conditions have brought injuries and occupational diseases and hazards to a position of primary importance to the community.

Inasmuch as the line of demarcation between major and minor is so ill defined, some of the contents of this number may be considered out of their sphere, and rightly so; others may strike the reader as too minor. But what one knows the other may not know. The effort must be judged by the whole and not by the individual parts.

Topics and authors were selected with care, and we wish especially to express our appreciation to Doctors Walter Coakley, Bradley L. Coley, L. Kraeer Ferguson, Herbert C. Fett, James Graham, Charles Gordon Heyd, Joseph A. Hyams, Arthur

Krida, Jerome M. Lynch, Louis E. Phaneuf and Max Thorek for their help and counsel in arranging this number.

To the authors who so kindly gave of their time in preparing papers on these common, minor topics we give our sincere thanks.

Frankly, this issue was not designed for the surgeon of great skill and wide reputation, or for the seasoned teacher of surgery or its branches. It was designed for the men laboring in the far away places, and to them we hope it will prove of practical help and value.

T. S. W.



Subscribers to THE AMERICAN JOURNAL OF SURGERY visiting New York City are invited to make the office of the publishers (The American Journal of Surgery, Inc., 49 West 45th Street, New York) their headquarters. Mail, packages or bundles may be addressed in our care. Hotel reservations will gladly be made for those advising us in advance; kindly notify us in detail as to requirements and prices.

# WOUNDS AND THEIR COMPLICATIONS

W. WAYNE BABCOCK, M.D.

Professor of Surgery and Clinical Surgery, Temple University School of Medicine

PHILADELPHIA, PA.

THE very common subject of wounds looms larger and larger these later days as swiftly moving vehicles create havoc upon our highways. Incised wounds are commonly due to windshield glass that breaks and divides tissue, often of the face. If the larger vessels of the neck, arm, groin or thighs are opened, a percentage of the victims die of uncontrolled hemorrhage, usually because bystanders do not understand the application of an improvised tourniquet or do not realize that hemorrhage even from a large vessel may be arrested by pressure or by pinching the artery between the thumb and finger until expert assistance arrives. When the injury involves the very vascular tissues of the head, satisfactory healing should occur after thorough mechanical cleansing despite the free use of antiseptics and even some degree of tension. The wound may be flooded with one-half strength tincture of iodine, grease removed with turpentine or ether, dirt-begrimed tissue trimmed away and after adequate hemostasis, bleeding vessels controlled with very fine (000 to 0) plain catgut or wire, then united very accurately with 35 gauge rustless steel wire or horsehair, without drainage, and healing free from reaction may be expected.

Apart from a permissible compression bandage to limit oozing during the first twenty-four hours, no dressing for wounds of the face is necessary. Dressings about the openings of the mouth, eyes and nose are particularly objectionable as they retain decomposing secretions in contact with the wound. Infection or a poor cosmetic result from an incised or even the average lacerated wound of the face or scalp, as a rule, indicates a slipshod operation or lack of surgical skill.

When a part of less vascularity, as the hand, or particularly the foot, is involved, much greater care is necessary in order that the vitality of the tissues be not destroyed by manipulation, strong antiseptics, the tension from tight sutures or lack of rest. Here the part should be given absolute rest, at least until primary union has occurred, and should the injury be at all extensive, general rest by keeping the patient in bed. Rest favors minimal exudate, primary healing and early recovery, and insures against the spreading, destructive infection so often seen when partly devitalized and contaminated tissue is subjected to early movement. Drains are not to be used unless the patient falls into such shock that the operation cannot safely be prolonged. They provide a path for the entrance of surface bacteria to the depths of the wound. At times, they are used to salve the conscience of the operator who knows he has been inexcusably careless in his wound sterilization or hemostasis. A drain is justified in a clean wound only for uncontrollable oozing. Even in the most radical amputations of the breast, we do not use one. As a rule it is better to occasionally evacuate a sterile hematoma between stitches at the second or third dressing than to risk having the wound contaminated through a drain.

To reduce scarring, alternate sutures may be removed from the face or scalp, provided there is no tension, on the second or third day and the remaining sutures on the fourth or fifth day. With wounds of the limbs or trunk supporting sutures should be left in for a week, with the foot for eight days, or if the wound is under tension or there is a strain upon divided skin, fascial or aponeurotic planes, an adequate



number of supporting sutures to prevent separation should remain in place for from ten to fifteen days. Should infection develop, stitches are to be removed and wet, warm, non-irritating dressings used. A deforming or unsightly scar may be excised three or more months after complete healing and the edges of the wound then coapted with meticulous care.

*Contused closed wounds* with or without fracture are characterized by tissues so bruised and devitalized as especially to be subject to necrosis and infection. Of particular danger in extinguishing the limited residual life of the part is the tension resulting from hemorrhage and edema. If tension is prevented, tissues that seem to be hopelessly damaged and are therefore thought to require amputation, frequently recover in a surprising way with little evidence of infection or necrosis. Tension results chiefly from the restraining skin and fascia which in a severe crush or contusion should be divided freely in the axis of the limb, if necessary on two sides. The divided skin and fascia will then separate widely. If the sheaths of muscles are also tense, these should be freely opened. The skin should, of course, first be carefully cleansed with ether or turpentine followed by tincture of iodine of  $3\frac{1}{2}$  per cent strength. Bleeding vessels should be ligated with fine (No. 35 B. and S. gauge) soft alloy steel wire, and fractures should be reduced without internal fixation or undue manipulation. If there is a marked tendency to displacement, continued extension by Kirschner wire or Steinman pins may be used. A very copious wet dressing of warm 1-4000 bichloride of mercury on fluffed gauze surrounded by cellophane or similar impermeable layer and finally a heavy encasement in sterile cotton, held by a lightly applied supporting bandage, is used. Unless complication develops, the dressing should not be removed for three or four days. This is the treatment to be used for crushing wounds of the extremities during the early period while there is any question as to the viability of the tissues. In many severe cases it enables

one to best determine the necessity for amputation.

**CASE 1.** A brakeman was admitted with his forearm crushed nearly flat between the bumpers of an old-fashioned freight train; the skin was tense, no pulse was detected at the wrist, and there were multiple fractures of the radius and ulna. Immediate amputation through or above the elbow was considered essential by consultants.

*Treatment.* Following sterilization of skin, one volar and one dorsal incision was made through the skin and fascia from the elbow into the hand. The muscular sheaths were found to have been crushed apart. The multiple fragments of the radius and the ulna where displaced, were gently pushed back into position and overlaid by muscle. Warm, wet antiseptic dressings were applied as described above.

*Result.* Granulation and healing of the widely open wounds occurred without necrosis or loss of tissue and there was bony union with a strong somewhat flattened forearm of excellent function.

Many surgeons have hesitated to incise badly contused parts or at the most have attempted to relieve tension by inadequate multiple punctures. Where the vitality of a limb is in jeopardy from a crush, all tension should be released aseptically by one or more long incisions reaching from uninjured tissue above to uninjured tissue below.

On the head, neck and trunk, the vitality of the tissues is so great that the long relaxing incisions mentioned are rarely necessary. However, large hematomas may produce serious pressure symptoms so that aseptic evacuation through a large aspirating needle or by incision may be indicated, preferably some days after the primary hemorrhage has ceased. If a large artery such as the iliac, femoral or axillary has been ruptured, the state of shock, the vitality of the limb, the local damage to the tissues, the ability to temporarily control the flow of blood from the artery and the skill of the surgeon should all be evaluated. An emergency operation upon a badly shocked patient with a ruptured main artery has a high mortality and is indicated

only when it is evident that the hemorrhage or oncoming gangrene will cost the life of the patient in which case there should be no delay. If the patient is in fair condition and the bleeding can be controlled above the field of injury by tourniquet, direct compression, or temporary ligation of the artery, it may be possible to evacuate about the artery and do an arterial suture, or at least determine the necessity for an amputation. In the average case a pressure pad, and a bandage evenly applied from the phalanges to a point above the injury will limit the size of the hematoma, and the operation for the false traumatic aneurysm may be delayed until conditions are more propitious.

In all cases the toes or fingers should be exposed so that interference with the circulation may promptly be detected. If pain continues, the surgeon should search for the cause without delay. An overlooked dislocation, an unreduced fracture, a tight bandage or cast, a beginning pressure sore, or an iodine or hot water burn are common causes of distress that should not be neglected. In one little girl the physician made traction for a broken leg through a shoe despite the child's suffering. After two weeks the removal of the shoe revealed great sloughs, exposed tendons and a permanently crippled foot, all due to the pressure of the shoe. An uncomplicated wound should not cause intense pain.

*Contused and lacerated wounds* including open crushing injuries have the element of potential infection, the avoidance of which depends largely upon the first treatment. The surrounding skin should be aseptized, the wound flooded with 3½ per cent tincture of iodine and mechanical sterilization of the wound carried out by excising with a very sharp scalpel all tissue that is devitalized or impregnated with dirt. Bone containing dirt should be removed with a sharp chisel, not by scraping. Vessels should be ligated with fine alloy steel wire as most other materials form a nidus for infection. Such wounds of the head and face, and most wounds of the neck and trunk may then be immediately and very

accurately closed without drainage with the fine (No. 35 or 36 gauge) annealed rustless steel wire. With a meticulous technique primary union with slight scarring is to be expected. There is little excuse for the suppurative of any wound of the scalp or face. In children under ten years of age, with wounds of the neck, in Negroes and others with a constitutional tendency a keloid thickening of the scar may develop.

With a lacerated wound of an extremity, tension and lack of blood supply may cause the loss of the patient's limb or his life. The treatment of crushing and lacerated wounds of the extremities consists therefore in careful debridement with the least possible traumatism to living tissues and the prevention of tension, if necessary by very long incisions in the axis of the limb carried freely through constricting skin, fascia and muscle sheath as previously described. Skin sutures are only permissible where and when they produce no tension. Copious warm, wet antiseptic dressings are valuable. Distal portions of the arm or leg that hang from what seems like only a small pedicle of soft tissues may not infrequently be saved.

CASE II. One hand of a man was lacerated and contused by the explosion of a bomb he was holding. The thumb and metacarpal bone were dangling from a ribbon of soft tissue 2 cm. wide containing a small branch of the radial artery. The head of the first metacarpal was fragmented and many phalanges were fractured, and two fingers were lacerated, pale and bloodless. Amputation of thumb was urged by several consultants. The thumb and bony fragment in the joint were replaced and held in position by a few fine sutures in the muscle, the skin and fascia not being sutured but copious, warm, wet, antiseptic dressings were applied.

*Result.* Healing was without suppuration or necrosis with restoration of one-third of the normal movement of thumb.

Böhler leaves the wound entirely open and exposed to the air, protected from dust only by a single layer of muslin and obtains excellent results. He obtains reduction and retention of compound fractures by the Steinmann pin or Kirschner wire passed

through the bones at a distance from the injury and held in a supporting frame.

With severely contused and lacerated wounds of an extremity after sterilizing and debriding the wound, divided parts may be gently apposed, but not to the extent of adding to the tension or traumatism. The prevention of secondary tension or retention of secretions is the first consideration; formal anatomical restoration often is best delayed until the vitality of the tissues has been regained. A common mistake with lacerated wounds is meticulously to suture divided muscles, tendons, nerves and skin with resulting tension, necrosis and spreading infection.

**CASE III.** A lacerated wound of the hand with division of the tendons and a fracture of the metacarpals resulted from the fall of a large wheel. Two hours were devoted to the immediate careful suture of divided tendons, alinement of bones and closure of the skin.

**Result.** A widespread infection involved the forearm and the hand, lasted for months and resulted in a disorganized and nearly useless member.

Thorough debridement is especially important if there is the likelihood of bacterial contamination as in wounds from gunshot or the fang or claw of lower animals.

**CASE IV.** Lacerated wounds of the hand with fractured metacarpals resulted from bite of a large monkey. All the wounds were sutured and covered with gauze dressing.

**Result.** A prolonged, agonizing infection, swollen, very painful, crippled hand with septic osteitis and purulent sinuses one year later.

**CASE V.** Dog bites of both hands and wrists were treated by antiseptic cleansing and gauze dressing without debridement, relaxing incisions, warm, wet, antiseptic poultices, or immobilization.

**Result.** Infection with final loss of one hand and crippling deformity of the other.

**Infection by the *Bacillus Welchii*.** The spores of the gas bacillus carried into the wound with minute particles of woolen clothing, intestinal discharges or street dirt are not destroyed by permissible antiseptics, and cannot certainly be removed by debridement. The gas bacillus and re-

lated organisms however seem unable to start infection in a well vascularized living tissue. It is in devitalized muscle, or in muscles the blood supply to which has been arrested by the injury or by the secondary tension within the sheath that this organism colonizes, causing a putrid form of gangrene that with much gas and liquid exudate spreads from muscle to muscle. A wound may contain many spores of the Welch bacillus and yet heal without reaction. Other pathogenic bacteria may likewise remain in a wound without harm, provided no semidevitalized, dead tissue or blood clot is present.

One should think of gas bacillus infection after any crushing or gunshot injury, especially of the extremities, when there is delayed or increasing shock without loss of blood sufficient to cause the symptoms. Prostration and a rapidly rising pulse rate with cold skin and high rectal temperature are common findings. The crackling of the tissues on palpation, the gas in and between the muscles shown by roentgenogram, the later foul, brownish, gas-filled wound secretion are pathogenomonic. Dependence should be placed early upon the wide opening of the limb and the removal of all devitalized soft tissue. Often this necessitates the excision of entire muscles which may be pale and firm as if cooked. For the advanced case with the patient delirious, nearly pulseless and apparently moribund, a high guillotine amputation is at times life-saving.

The Welch organism may remain in the tissues for months and produce gangrene only when the muscle is damaged or becomes avascular.

**CASE VI.** An aneurysmal dilatation of the anterior tibial artery in a young man was caused by the entrance of fine bird shot about fifteen months previously. There was no inflammatory reaction in the leg. The angiomatic mass was resected, and one or two bird shot was removed from apparently healthy muscle. The open muscular sheath was sutured under marked tension and without drainage. Rapid development of gas gangrene in the leg followed with death within seventy-two hours

despite the injection of two hundred dollars worth of combined Welch antitoxin. In this case the Welch bacilli or spores carried into the tissues with the bird shot had remained dormant until tension interfered with the blood and lymph circulation in the muscle, when they rapidly developed to then swarm out and overwhelm the body.

*Thyroid crisis* may be precipitated by injury, a relatively slight operation or even a mental shock, with increasing tachycardia, tremor, restlessness, progressive hyperpyrexia (by rectum) and at times death in twenty-four or thirty-six hours. The crisis is to be suspected if there is a visible or a palpable goitre or thyroid nodule, but it should be remembered that the goitre may be entirely intrathoracic and only visible on the roentgen film. In such a case the high internal temperature is especially dangerous for the central nervous system. Adequate refrigeration, the free use of iodine and glucose solutions by vein and iodine by mouth and rectum are the best known methods of treatment.

#### ANTISEPTICS

Progressive repair, reduced toxemia and rapid elimination of necrotic tissue are very much more important than high bactericidal action of the antiseptic applied to the wound. A healing contaminated wound is preferable to a sterile dormant wound. Many of the newer antiseptics, while they may have high bactericidal power, when they are applied to the wound produce a sluggish condition with delay in healing. A similar retardation of healing occurs when the dressing is impregnated with certain of the older germicides, such as solutions of formalin, carbolic acid, lysol or other cresol. None of these substances should be used as a wound dressing. As is well known, a wet dressing of even a weak solution of carbolic acid has produced gangrene of fingers and toes. On the other hand, granulations grow rapidly under a weak wet dressing of bichloride of mercury, iodine or even bromine. Bromine in 1:3000 to 1:5000 strength has a special value for very fetid wounds.

Dakin's solution is not applicable in ordinary practice and should only be used when the wound is wide open. Injected into the fresh wound under tension it produces necrosis. In the abdomen it dissolves the mesentery down to the blood vessels. It is essential that it be applied copiously every two hours following the very precise technique elaborated by Carrel.

For irritated wounds or where the skin is excoriated, liquor aluminii acetatis of the National Formulary, diluted 1 to 4, is of value. For tissues of low vitality as in a diabetic or arterosclerotic the mildest and least irritating antiseptics only should be used.

#### SUTURES

Sutures have attracted more and more attention during recent years. We must remember that, while absorbability is very desirable, all sutures derived from lower animals are objectionable. Catgut produces reactions which retard healing and favor infection. It is especially harmful in infected wounds and on mucous surfaces. After thyroidectomy, surgeons have long wondered why it was that the wound became edematous, required drainage and did not heal as well as other wounds of the neck. It was thought that the secretion from the thyroid or the exposure of the trachea was responsible. We were impressed likewise until after we studied the undesirable reactions of the tissues to catgut in about 130 patients. Implanted in the skin catgut causes a red flare and a wheal in twenty-four hours which so progresses that at the end of a week there is a zone of reaction and necrosis about each strand. Thus firm healing is delayed until the catgut has been absorbed and the local damage to the tissues from the catgut repaired. From silk there is only a slight redness at the end of a week; from rustless or alloy steel wire no flare or wheal even at the end of four months. With the substitution of silk or wire for catgut in thyroidectomy the wound heals like other wounds of the neck without reaction or drainage. The wire tied in a small knot and placed in a septic

wound, becomes buried without producing local irritation or a sinus. Therefore, we have used it increasingly for several years past, burying it in abdominal wounds and in hernioplasties, and using it as the sole material for suture and ligature in infected or contaminated wounds. We believe it solves much of the difficulty in closing cleft palates, duodenal and vesicovaginal fistulas, the suture of the ureter and bladder. Size 35 and 36 (B. & S. gauge) is hair-like and is used for fine plastic work and fine ligatures; No. 32 and No. 30, about the size of 000 or 0000 catgut, but much stronger, are used to unite strong fascias or as a through and through suture; size 18 to 22 is very strong and is used to wire bone.

Suturing with living fascia to me recalls the barbaric surgery of savage tribes. Heavy coarse needles open great holes in delicate aponeuroses and crudely weave bands of fibrous tissues into the depths of the wound. I am informed that the younger Coley is soon to publish the end results from the method in treating hernia with a report of about 17 per cent of recurrences.

*Residual infection* should be considered with a wound that has been seriously infected but has healed. Therefore, how long a delay should be practiced in such a case before re-operation is done for an ununited fracture, divided tendons or nerves? Usually at least three months, but it is best to first test the part by free manipulation under gas anesthesia. If this is not followed by serious local reaction, the operation may be done. If it is followed by a marked local reaction or what occasionally occurs, the development of an abscess, of course, a much longer delay should be practiced. With infected fractures during the inflammatory period before free suppuration has been established, operative manipulation may produce a fatal septicemia.

#### THE APPLICATION OF COLD OR HEAT

Cold retards healing and the resistance of the body to infection. It has little germicidal value, although it may reduce the activity of bacteria. Warmth favors wound healing and high temperatures that are

tolerated by peripheral tissues markedly impair the pathogenicity of a number of bacteria. Fever, kept within such limits that the central nervous system is not injured, is a valuable therapeutic agent in infection. Therefore, an injured part should be kept warm. Refrigeration is only to be considered in the early hours of a rapidly destructive local infection to hamper bacterial activity until there is time for protective bacteriolytic and antitoxic substances to be formed. Even in this early stage heat may serve a better purpose. Ice bags or cold solutions should not be used upon tissue of low vitality.

#### INFECTED WOUNDS

Infected wounds may be divided clinically into two great classes. In the first class we operate; in the second we wait. *In the first early operation cures; in the second it kills.* This applies not only to wounds, but also to peritonitis and other forms of infection. The first class is typified by the staphylococcus which forms an endotoxin and an exotoxin which act upon endothelium with the production of thrombi in blood and lymphatic vessels and plastic exudate on serous surfaces. The thrombi and plastic exudate block off the infected area from the rest of the body, limiting the general reaction, but causing a local ischemia and necrosis. Thus the center of a boil or carbuncle dies and may later be expelled as the "core." In the skin the localized thrombosis may lead to limited areas of gangrene. The local tension from the inflammatory exudate increases the damage. Thus the process may be arrested or limited by early incisions or, as with a carbuncle, by excision of the thrombosed area. In osteomyelitis the destructive inflammation may be at once arrested by the early drilling of the bone with a gimlet to relieve tension. With a beginning furuncle we may arrest the process by destroying the microorganisms before the thrombotic process has fully developed. To this end 0.5 to 2 minims of liquified phenol is injected through a very fine needle into the center of the boil, a procedure not to be used on

the fingers or toes. For the more superficial pustulations on hairy surfaces as the scalp or axilla, the frequent application of undiluted tincture of green soap with exposure to the air is particularly beneficial. For an extensive staphylococcic cellulitis free incisions and warm, wet dressings of 1:5000 bromine solution are valuable. In peritonitis the exudate is protective and is not to be removed. Years ago Dudgeon and Ross showed that a mixed colon bacillus and staphylococcic peritonitis was less dangerous than a pure colon bacillus peritonitis. Infections by the staphylococcus, the pneumococcus, the bacillus pyocyaneus, the gas bacillus we treat by sterilizing, incising or debriding early. Free drainage, no sutures, wire instead of catgut ligatures, warm, wet antiseptic dressings and rest are important. Against a few of these infections there is an antitoxin of some value.

*Class II* is represented by a group of pathogenic microorganisms of which the streptococcus is a striking example, that do not as a rule produce thrombic and plastic exudative reactions and, therefore, tend to any early and wide diffusion through the blood and lymphatic channels. The exudate, as a rule, remains liquid, but often causes a marked edema with redness, swelling and pseudo-fluctuation suggesting an abscess. Usually this exudate is finally spontaneously absorbed. The general reaction may be early and marked and a bacteremia established in a few hours. For example, a surgeon pricks himself while operating for a streptococcic infection. In two to four hours there is a chill and fever and red tender streaks mark the spread of the coccus through the lymphatic vessels radiating from the wound. If the puncture is incised or excised, additional lymphatic spaces are opened, a more severe chill, higher temperature and death from blood stream infection commonly follow. The proper treatment is immediate absolute rest in bed. The lymphatic circulation should be reduced by keeping the extremity splinted, but not constricted. The wound should be covered with an antiseptic ointment, as unguentum oxidum

flavum or a wet dressing, and not handled, squeezed, incised or disturbed. To supply complement, a transfusion of 150 c.c. to 200 c.c. of typed blood should be given every third day until the temperature remains normal.

If the donor will permit, the richly leucocytic blood of an immuno transfusion may be used. Fifty million killed typhoid bacilli are injected into the donor's blood stream with resulting chill, sweat and fever. Six or eight hours later, or at the height of the resulting leucocytosis the transfusion is made. Transfusion has a high mortality in infancy, and many more babies have been killed than saved by the injection of blood.

In acute osteomyelitis we have examples of the two classes of infection. The common form occurs in childhood or youth, is due to the staphylococcus, and may be aborted as previously mentioned by venting the bone. The second type, due to the streptococcus develops in infants, and the mortality is markedly increased by early operation.

Anthrax also belongs in Class II. The pustule which closely resembles that of vaccinia is usually seen in those who work with imported hair or hides. Formerly the lesion was excised, cauterized, injected with carbolic acid, or other antiseptic solution, and this militant treatment resulted in a fatal anthrax septicemia in 30 to 50 per cent of the patients. Now we keep the patient in bed, protect the pustule from movement, scratching and meddlesome consultants, with a layer of yellow precipitate ointment, thick soft dressings and a splint, and about 95 per cent of the patients recover within two weeks.

#### DRAINS

While the mortality may be greatly reduced by delay in draining a mixed streptococcic appendiceal abscess, if the pus is then drained through the free peritoneal cavity, 6 per cent or more of the patients will die of peritonitis. We, therefore, prefer to make a muscle splitting incision close to the right anterior iliac spine, strip the unopened peritoneum from the hollow

of the ileum, and locate the abscess from behind the peritoneum by the finger, which also guides a closed curved Mayo scissors into the abscess cavity. The scissors is then opened and withdrawn and a drain introduced. This method, if it can be carried out, largely eliminates the late mortality.

*Deaths from the Early Removal of Drains.* With a virulent, and especially a Class II infection, gauze drains should not be removed before the ninth day or before they have loosened spontaneously. After draining for septic appendicitis, or any streptococcic infection, do not let an interne or anyone else pull out the drain on the second or third day. The lymphatic spaces are thus torn open, a chill and rising temperature frequently follow, with death from a blood stream infection. In one year in one hospital in Philadelphia 6 deaths were attributed to this cause. Remember also that drains often fix the infection. Those who in peritonitis drain to the bottom of the pelvis have the greatest percentage of secondary pelvic abscesses. Again, a gauze drain should rarely be renewed. When impregnated with wound secretions it becomes more of a cork than a drain. If continued drainage is necessary, fill a glass syringe with a modified Beck's plumb, 25 to 50 per cent of bismuth subiodide in white petrolatum. Squeezed into the wound without tension, this causes no pain and facilitates drainage and early closure. It may be renewed without undue pressure only every four to eight days.

#### SKIN GRAFTING

*Granulating wounds* if large may epithelialize so slowly as to greatly retard convalescence. Skin grafts are often applied when a quicker and much better result could be obtained by sterilizing the granulatory surface with a 10 per cent solution of chloride of zinc, blotting and excising the granulation tissue with a sharp knife and then liberating the adjacent skin, which is slid over the defect and sutured. The area may be so large however that skin grafting is desirable.

It is to be remembered that only autogenous grafts live. Not many years ago attempts were made to graft frog skin, the lining of an egg, and the bones of dogs into humans. None of these tissues endure. We cannot even graft skin from a mother to a child, or from one member of the same family to another, unless they are homologous twins.

Only autogenous grafts, grafts made from the same person, will survive. It is true that a graft from perhaps a related person may appear to "take" for one or two weeks, but then it melts down and finally disappears, although one may be misled by the fact that some living sebaceous or sweat glands remaining in the grafted area have in the meantime started to form new islands of skin. The cosmetic result from small Thiersch or pinch grafts is very poor. Large Thiersch grafts, split skin grafts or fitted and sutured full thickness grafts should be used, especially on exposed portions of the body. To ensure a successful "take" the even compressure from rubber sponges incorporated in the dressings is important.

#### SUMMARY

The treatment of the various types of incised, contused and infected wounds is notoriously poor in a large percentage of our hospitals as well as in private practice.

Disfigurement, mutilation and even death daily express the widespread failure to appreciate and apply the simple principles underlying the surgery of traumatism and infection. Methods of treatment for incised, contused and infected wounds are described and errors illustrated by concrete examples. The selection and application of sutures, ligatures, antiseptics and dressings are indicated and the great danger from transfusing babies mentioned. Methods of preventing or aborting infectious processes are given.

Common tragedies from intervention in Class II infections and from the mishandling of drains are emphasized and attention is directed to the faulty use of skin grafts.



# TREATMENT OF OPEN INFECTED WOUNDS

HENRY S. F. COOPER, M.D.

Instructor in Surgery, College of Physicians and Surgeons, Columbia University

NEW YORK

**W**OUNDS become infected because bacteria are present, grow and multiply within them. The mere presence of bacteria in a wound does not mean that it is infected but rather it is considered as a contamination, and probably exists in every wound, surgical or traumatic. In the clean surgical wound the contamination is usually so slight that the bodily defenses dispose readily of the bacteria and make healing by first intention possible. In traumatic wounds seen within the first few hours surgical cleansing combined with body defenses will often produce the proper conditions for primary union.

If a wound becomes infected all thought of primary union must be abandoned. The attention of the surgeon must then be turned to controlling the infection and promoting healing by second intention. The wounds which must be treated as open infected wounds fall into three classes as follows:

1. Wounds which have been sutured and have become infected;
2. Wounds which have been made surgically in the treatment of preexisting infection-incisions;
3. Contaminated wounds in which the surgeon believes that infection is bound to occur, either because of the degree of the contamination or the time elapsed before treatment.

When a wound heals by second intention it heals *from the bottom up*. Its surfaces throw out granulation tissue which fills the defect. From the skin edges new epithelium advances over the top of this accumulation until all is covered. Then follows a gradual devascularization and contraction of the granulation tissue until the scar reaches its final form—contracted, avascular, white—

many months later. Why does this process start? Why does it stop when healing is completed? The answers to these questions lie deeply buried among the mysteries of Nature.

In the vast majority of cases infected wounds heal spontaneously with no care other than cleanliness and protection; "We dress the wound, God heals it."

There are a few ways in which we can be helpers as well as interested observers in this process of wound healing.

## CONTROLLING THE INFECTION

By applying aseptic precautions we hope to keep bacteria from entering a wound. By its very definition an infected wound already has bacteria in it. The question naturally arises, "What is the use of observing aseptic precautions in a wound that is already septic?"

In its early stages an infected wound is always surrounded by a greater or lesser amount of cellulitis due to the *penetration inward* of bacteria and their toxins. This is evidence of the fact that its surfaces are not sufficiently walled off from the surrounding tissues and that they are still permeable to infection. Due to the effects of time, or the relief of tension by proper drainage, or both, the wound becomes impervious to infection. This is evidenced by the fact that the cellulitis subsides and the surfaces become covered with healthy granulations. Healthy granulation tissue, although more fragile, is nearly as impervious to infection as the skin itself.

Therefore, *asepsis is necessary in the early stages while the surfaces of the wound are still permeable*. True, the wound already harbors bacteria of one or more types; nevertheless, it is important not to intro-



duce some other type which might make more trouble than the ones already there.

Asepsis is not necessary after the wound has become impervious to infection. This stage is reached after all tension has been released, after all cellulitis has subsided—after the surfaces have become covered with healthy granulations. When a wound reaches this stage gross cleanliness with soap and water is infinitely more important than the microscopic form. The patient can often take care of such a wound himself as long as he observes normal care in washing and protecting it.

#### THE DRESSING

Frequent dressings are desirable for purposes of cleanliness if for no other reason. As has been already stated, aseptic precautions should be strictly observed in the early stages but are not so important later. Gross cleanliness should be observed at all times. The free use of soap and water is highly recommended. Purulent exudate should be cleaned away and crusts should be removed. Good mechanical cleansing always makes a wound feel better. An ointment dressing is more comfortable than a dry one, vaseline or boric ointment being as good as any. This measure promotes free drainage by hindering the formation of crusts and also prevents the discomfort caused by dressings that stick.

While the wound is sensitive it is always more comfortable if the dressing is voluminous. The application of a comfortable dressing is an art in itself.

#### CARE OF GRANULATION TISSUE

It is important that the granulation tissue should be healthy at all times. If it loses its vitality, healing is delayed and the danger of reinfection of the surrounding tissues increases. Healthy granulations are pink and shiny, and bleed easily. Unhealthy granulations lose their lustre, become dark red and may be covered with a greenish grey exudate. Healthy granulations are the rule in normal, healthy individuals. Nevertheless, any granulation

tissue may become unhealthy, especially in wounds about the ankles and feet where the circulation is not as good as in other parts of the body. Unhealthy granulations may be restored to vigor by rest, elevation of the part, heat and moisture. Normal salt solution is as good as any for hot soaks and wet dressings. Dry heat and sunlight are also beneficial.

At other times the granulation tissue may be too vigorous. It may grow so fast that it advances above the skin surface before the new epithelium has a chance to grow over it, with a consequent delay in healing. In such cases it is necessary to demolish these exuberant granulations. This can be best accomplished by cauterization with a stick of silver nitrate. Great care should be taken not to damage the delicate new epithelium at the same time.

#### SHAPE OF THE WOUND

The wound ideally shaped for healing by second intention is the one that has its greatest area at the skin surface. This gives the greatest opportunity for the defect to fill with granulations before the skin grows over the top. It also allows the freest possible drainage. This ideal should be borne in mind while preparing a wound for healing. If a sutured wound becomes infected *all* the sutures should be removed and it should be laid wide open. If an abscess is incised it should be opened with a wide incision. Undermined edges and pockets should be viewed with suspicion and eliminated whenever possible. If the skin grows across before these areas are entirely filled with granulations, there is danger of the formation of residual abscesses which harbor infection and continually discharge pus through sinus tracts. These usually persist until they are laid wide open by a secondary operation.

#### FOREIGN BODIES

Any foreign body in an infected wound acts as an irritant and, if not removed, becomes a cause of continuous purulent discharge. As healing progresses a sinus

tract will form connecting it with the outside. It is important, then, that all foreign bodies be removed as soon as possible. These may find their way into a wound at the time of its infliction. Buried, unabsorbable sutures act as foreign bodies in the event of infection. Furthermore, dead tissue often sets up a similar reaction. Its careful removal expedites healing.

#### DRAINS AND PACKING

In certain types of wounds, for one reason or another, it may be undesirable or impossible to achieve the ideal shape for free drainage and healing. A wound may be very deep and narrow, or it may be on the face or neck where free opening is undesirable. Under these conditions it is important to allow free exit for the purulent exudate until such time as the depths become filled with granulation tissue. This can be accomplished by the judicious use of drains and packing.

A drain establishes a tract along which the exudate finds its way to the outside. Rubber dam or small rubber tubing provides the best material. It is rarely necessary to drain a minor wound for more than forty-eight hours. Care should be taken not to leave a drain in too long. It tends to create a foreign body reaction within the wound with a consequent increased exudate. The inexperienced observer may consider this as added evidence of the value of the drain and thus leave it in until a permanent sinus is formed. If the tract to be drained is long it is advisable to shorten the drain by degrees at consecutive dressings. This will tend to allow the tract to heal to the tip of the drain each day, thus obviating the danger of the formation of a residual abscess.

Packing can be used to improve the shape of a wound. It will keep the skin edges apart until the pockets beneath are obliterated. It will keep undermined areas open until they fill in from their depths. As in the case of drains, packing is rarely necessary after the first forty-eight hours.

If not used judiciously it may act as a plug and thus defeat its own end.

The indiscriminate use of drains and packing is to be avoided. They should not be introduced unless the surgeon hopes to gain a definite purpose thereby. The very fact that there is an open wound does not mean that it has to have something put into it.

#### ADHESIVE STRAPPING

If all is well with a wound and if it is rapidly filling with healthy granulations, there may come a time when healing can be expedited by drawing its edges together with strips of flamed adhesive. This procedure will lessen its size and therefore decrease the amount of work to be done by the healing process in filling and covering it. If this procedure is adopted care should be taken not to create pockets thereby. It is also important not to put the adhesive strips so close together that there is interference with free drainage.

Secondary suture of this type of wound should never be employed. The passage of the suture through the wall of granulation tissue makes infection of the surrounding tissues almost inevitable. All the advantages of secondary suture are obtained with flamed adhesive, with none of the dangers.

#### SUMMARY

1. If a wound becomes infected, all thought of primary union should be abandoned.
2. When a wound heals by second intention it heals from the bottom up.
3. Asepsis is necessary in the treatment of open infected wounds until they become impervious to infection.
4. Comfort, cleanliness and protection are important considerations.
5. Care should be taken that there is free drainage at all times and that the wound heals from the bottom before the epithelium grows across the top. Drains and packing may be necessary to achieve this end.

# MICHEL CLIPS IN SKIN COAPTATION

THURSTON WELTON, M.D., F.A.C.S.

Attending Gynecologist and Obstetrician, Long Island College and Greenpoint Hospitals

BROOKLYN

MICHEL metal clips are used for the coaptation of the skin in incisions and lacerations. If the parts are



FIG. 1.



FIG. 2.



FIG. 3.

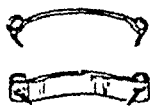


FIG. 4.

under tension they should not be used except the tension is relieved by interrupted stay-sutures. The author has used Justrite Michel clips for nearly thirty years, especially in the skin coaptation of abdominal wounds in gynecological surgery.

The use of some kind of wound clip dates back many centuries. The Romans used clips, many of which were of fancy design. The first physician to employ them in Europe was the Swiss surgeon, Walter Ryff (1536). The "fibula chirurgica" has been referred to as a form of clip. Celsus, however, has listed a different explanation in his Latin surgical nomenclature. With many it is a debatable point. The Somali use acacia thorns in the suturing of wounds, a rather primitive antecessor to the skin clip. Other African Negroes make use of the thorns of the "mimosa," the gum arabic tree. Ants have been used in bringing cut skin edges together. This is mentioned in the ancient Indian textbook, "Ayurveda," written by the Indian physician, Susruta, who lived in the time of Galenus. We read, "In order to close wounds efficiently, and in order to have them heal faster, one should resort to red ants who should be made to bite into the two wound margins in such manner that their mandibular

forceps draw the wound margins together; then the bodies should be severed from the heads."

Justrite Michel clips may be procured in four sizes: small, medium, large, and very large. In small wounds, and especially those about the head and neck, the small size is preferable. We find the medium or large size ideal in skin coaptation of abdominal wounds, although there are some who use the very large size and depend on personal preference, the result of experience.

The accompanying illustrations give the exact sizes of Justrite clips, and, also, how they are supplied on wire holders.

Clips are for skin closure or coaptation only. If the wound is a deep one, or tension on the wound will be exerted until healing is completed, one must not rely only on clips to hold the wound together. Clips take the place of various suture material in the continuous, subcuticular, or interrupted closure of the skin in wounds—that and nothing more should be expected of them.

Some of the advantages of clips in skin coaptation are:

1. They may be applied with less pain than is necessary in the taking of stitches. This is a distinct advantage in skin closure in individuals who are conscious, especially if their pain threshold is low, and in children.

2. They do not penetrate and tunnel the skin, thereby providing avenues for infection.

3. They cause no discomfort to the patient while in use.

4. They are easily and quickly applied, and painlessly removed.

5. Invariably the wounds if uninfected, following the proper application of clips,

are excellent. Although the cosmetic result is not important in covered scars, as on the abdomen, on exposed parts of the body, such as the face, neck, and arms the cosmetic result plays a large part in the patient's eyes.

There is an art in applying clips in skin coaptation. Before applying the clips all bleeding points in the wound must be stopped. Of course, this is a primary rule in all wound closure. Then, an Allis clamp or a hook is placed in the upper and lower angle of the wound, and the wound is slightly stretched lengthwise. This brings the skin edges into apposition. It is most important that the skin edges meet on the same level. If the edges are inverted or one edge higher than the other an unsightly scar will result.

Clip-holders or smooth edged anatomical forceps may be used to hold the clip. The operator or an assistant holds the skin edges together with a toothed forceps. If the wound is short and the skin edges approximated sometimes this is unnecessary. The clip in its holder is then placed over the skin and bent until the skin edges are coaptated. Care must be exercised not to close the clips too tightly. It is better to have them a trifle too loose than pressed together too tightly, thus burying the clip in the tissues. Clips are spaced apart from 0.5 to 1.5 cm., depending on the wound and its site. A good rule to follow is to place a clip where you would an interrupted suture.

Clips are removed in two to five days. Small clips used about the neck and face may be removed in two to three days. In abdominal wounds and wounds of the back and extremities they had better be left in situ for five days. Some men never leave a clip in longer than three days no matter where the wound may be. If they are left in longer than five days local areas of skin necrosis and infection may result.

Clips are removed by straightening them out, or cutting the top of the loop with a special small scissors. There are clip-removers and scissors for these purposes.

But should one not wish to use them, or does not have them at hand, he can remove the clips with two sharp pointed artery

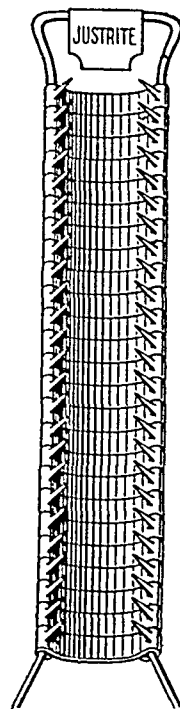


FIG. 5.

clamps. The base of the clip on one side is held firmly with one clamp. The other clamp is slipped under the bend at the top of the clip and held firmly. The clip is twisted in a straight line and removed.

For a few days clip-marks are present on the skin, but these soon fade out. Usually a month or six weeks after removal no traces of clip-marks can be seen. The scar is a hair line that will become invisible with time provided infection has not occurred, or a keloid has not formed.

The method of skin closure is mainly a matter of habit with most men. As a result of early training some continue to use needle and suturing material; others find clips ideal for emergency and office work. The writer, in thousands of patients has found their use in skin coaptation in abdominal wounds so satisfactory that he has no idea of changing to any other method or material.

#### SUMMARY

Justrite Michel clips are ideal for skin coaptation. They come in four sizes, from

small to very large. The medium or large size is preferable in abdominal, back, and extremity wounds; the small size is used in wounds about the head and neck. Care must be exercised to have the skin edges approximate on the same level, and the clips must not be clamped too tightly. They are removed in two to five days. In the absence of infection or keloid formation, if the wound edges are carefully coaptated and sealed with clips the resulting scars are uniformly satisfactory. The use of clips has many advantages in minor surgery and office work.



# BEDSORES (DECUBITUS)\*

MANUEL G. SPIESMAN, M.D.

Attending Proctologist, American Hospital

CHICAGO, ILL.

**B**EDSORES, cuticular necrosis, decubitus and skin ulcers are synonyms describing an annoying condition which affects mostly bedridden patients. The areas most frequently involved are those exposed to pressure, over the sacrum, the trochanters, the scapula, the spinous processes of the vertebra, the external malleoli and the heels and the internal condyles of the humerus (Figs. 1 and 2). In highly susceptible tissues bedsores may appear upon any portion of the body, such as those produced by the mere weight of bed clothes; a hand lying on the abdomen; or the mere resting of one cutaneous surface against another as may occur about the vulva or scrotum. In cases of extreme emaciation certain bones, especially the anterior superior spinous processes of the ilium, may protrude through the over-stretched and atrophic skin even without the added aid of external pressure.

Bedsore are most commonly the result of long continued pressure between the bed and some more or less superficial bone; this is augmented by the absence of the normal protection of the elastic layer of fat. Contributory causes are feeble circulation on the most dependent portions of the body; lack of tissue resistance as a result of disease; alterations in the intima of the blood vessels due to bacterial poison; lack of nutrition from capillary stasis; changes in the blood, etc.

Tinna pointed out that evaporation of fluids from the tissues which takes place in the presence of anemia is a contributing factor in the genesis of decubitus.

Fantus ascribes the appearance of bedsores to two factors, extrinsic and intrinsic. Among the extrinsic causes may be mentioned prolonged pressure, maceration and

traumatism and those resulting from intrinsic causes are lowered tissue vitality.

Bedsore are most frequently encountered in severe and prolonged fevers, accompanied by emaciation and prostration in such exhausting diseases as typhoid fever and osteomyelitis, for example. The condition also occurs in diabetes and Bright's disease, following operations on the aged, prolonged confinement to bed after Kraske operations and in certain lesions of the central nervous system, especially those complicated by paralysis. Constant soiling of parts with persistent discharges of feces and urine, wrinkles in the bed clothes, crumbs, maceration from perspiration, injury from rough handling, pressure from splints, casts, hot water bottles, tight bandages, etc., may also give rise to bedsores. Occasionally decubitus will develop following the use of local anesthesia. Severe injuries of the spinal cord or peripheral nerves are extremely liable to be complicated by a sudden appearance of extensive and troublesome bedsores.

The principal types of bedsores usually observed are the ordinary decubitus; and that appearing in connection with nervous lesions. Decubitus as the result of lesions of the nervous system differ from the ordinary form in no way except in their rapidity of extension and destructiveness.

## PATHOLOGY

Both varieties of bedsores probably originate in thrombosis of the smaller vessels; this gives rise to gangrene, sloughing and ulceration, extending more or less rapidly and extensively according to the resisting power of the tissues. Sometimes the causative infection is of a virulent type of streptococcus which produces necrosis;

\* From the Surgical Service of the American Hospital of Chicago.

or, anaerobic organisms in the area of the sacrum may be responsible for the condition. In such cases the process spreads

duration. He states that the skin is capable of withstanding very high pressure for a short period of time or even for a great



FIG. 1. Decubitus of left buttock; automobile accident resulting in fracture of right side of sacrum, fracture of superior and inferior rami of each pubic bone, separation of left sacroiliac articulation. Due to injury of the bladder patient was unable to void, necessitating use of retention catheter. Patient developed cystitis, pyelitis and hematuria. Urine was dribbling constantly into the bed. Because of the necessity of maintaining the fractures in good position, it was difficult to turn the patient. With the healing of the fractures the patient was turned on her abdomen.

rapidly and is characterized by a progressive gangrenous border.

Charcot and others have attempted to explain the peculiarities of bedsores following lesions of the nervous system by assuming the existence of certain trophic centers governing nutrition, damage to which results in neuroncrosis when aided by local pressure. However, such trophic centers have never been demonstrated with certainty.

Trumble suggests two factors in the production of bedsores, intensity and



FIG. 2. J. V., aged twenty-six years; bed sore over sacrum complicating acute gonorrheal arthritis (multiple). Slightest movement caused excruciating pain.

number of short periods, if there are intervals of freedom from excessive strain. Bedsores, according to Trumble, are produced as a rule, by quite moderate pressure acting continuously over a long period of time.

#### SYMPTOMS

The first thing noted in the development of bedsores is a dusky-red discoloration, due to passive hyperemia of the skin. This is followed by a purplish tinge, gradually changing to black as gangrene results. Infection soon takes place, followed by inflammation and ulceration. Exudation and pus appear and the surrounding tissues become red and swollen. Gangrenous sloughs separate, exposing a ragged unhealthy ulcer. This usually extends in all directions often causing marked loss of

tissue substance. The underlying bone frequently becomes exposed and may erode into the spinal canal itself (in decubitus over the sacrum). Death may occur from exhaustion, sepsis, pyemia or spinal meningitis. If healing occurs, disfiguring cicatrices may form, in some cases interfering with locomotion.

Ordinary decubitus is usually slow in formation but the form due to nerve lesions appear rapidly, with the production of large sores in relatively short periods of time; such bedsores cause no pain by reason of the existing cutaneous anesthesia. In ordinary bedsores pain is intense, especially after ulceration appears. Healing is slow, sometimes not occurring until the disease which caused it has subsided; or the injury to the nervous system remedied.

#### TREATMENT

*Prophylactic.* The backs of all very sick patients should be examined daily. Whenever the possibility of decubitus exists, suggested by cutaneous erythema disappearing on pressure, is present, the skin of vulnerable parts particularly should be kept clean, dry and free from pressure. Once or twice daily, parts soiled with urine and feces should be washed with soap and water. Care should be taken not to injure tender surfaces. The skin should be thoroughly dried and dusted with borated talcum powder, zinc stearate powder or anointed with salve, ore lastic adhesive should be used. Bed sheets should be changed often to prevent decomposition of perspiration and should be kept tightly stretched across the bed by pinning them to the mattress. Maceration of the skin from sweat, urine, fecal matter or pus should be prevented by the free use of absorbent material with a foundation of several thicknesses of newspaper.

Frequent change of position prevents bed sores. Nurses should be instructed to report where the patient shows disinclination to change posture. This should be remedied.

To improve the circulation of the tissues of the back, the back rub is the most important aid. Alternate hot and cold applications also help to improve circulation. If the skin is soft it should be hardened with 5 per cent silver nitrate or a saturated solution of alum in diluted alcohol; or spirits of camphor; or vinegar, lemon juice or salt, one dram to each pint of alcohol. If the skin is dry a piece of moleskin adhesive plaster or a dressing of flexible collodion may keep a harsh, dry skin from cracking. After each cleansing a little hydrous wool fat should be rubbed in or the following prescription, suggested by Fantus, used:

|   |                                      |       |
|---|--------------------------------------|-------|
| R   | Zinc stearate.....                   | 5.0   |
|   | Tincture of benzoin.....             | 5.0   |
|   | Scarlet Red ointment 5 per cent..... | 0.25  |
|   | Hydrous wool fat.....                | 30.0  |
|   | Liniment of camphor.....             | 180.0 |
|   | Mutton tallow.....                   | 500.0 |
| Sig. Melt the fats, add camphor liniment; when mixture is almost cooled, heat in tincture of benzoin and zinc stearate until a creamy mixture is secured. |                                      |       |

Pressure should be relieved with pneumatic rubber rings covered with cloth or by rings made from rolls of cotton which are placed beneath the pelvis and the heels. In fractures of the spine, put the patient on a pneumatic or water bed. Do not use pads of cotton beneath the vulnerable areas.

When lesions of the nervous system exist, bedsores usually appear sooner or later in spite of the most careful attention. If hemiplegia exists the paralyzed parts should be protected by the patient lying upon the sound side as much as possible.

If, in spite of all precautions a bedsore seems inevitable, which is evident by the fact that pressure no longer drives redness from the congested part, strict prophylaxis should be reinforced by the addition of tannic acid and dry heat treatment lauded by Latimer, which consists of a 5 per cent aqueous tannic acid solution neutralized to the pH of the blood by Seeger's method; this is sprayed on the vulnerable parts every hour. Between treatments the parts are exposed to dry heat from electric lights, an electric hair dryer or an infra-



red burner. Research work recently completed by Fantus has established a 10 per cent tannic acid in Ringer's solution as the most efficient form of tannic acid available. An additional application of 10 per cent silver nitrate further improves the results.

*Active Treatment.* The treatment of the bed sore per se is best accomplished by one of the following regimes: (1) tannic acid and dry heat (Latimer); (2) elastic adhesive plaster treatment (Carty); (3) insulin with or without parathyocresol (Powers).

*Tannic Acid and Heat Treatment.* Five per cent aqueous tannic acid alluded to above is sprayed on the parts every hour. Treatment is continued until a heavy coagulum is formed, which usually takes place in twenty-four to forty-eight hours. No dressings are applied after the coagulum appears, nor is sterile gauze used to keep the coagulum clean and dry. Healing occurs as in burns and as the coagulum separates at the edge it is clipped away. If infection complicates a bed sore, treat it with wet compresses of hydrogen peroxide, mild solutions of boric acid or Dakin's solution. When the infection subsides resort to the tannic acid and heat treatment. If infection occurs under the coagulum, this must be softened with sterile petrolatum and removed. The infection is then treated as previously outlined. When controlled, the tannic acid and heat treatment are resumed. Occasionally it is necessary to remove the coagulum several times because of infection. Each time the crust is removed the wound will be found to have decreased in size. A virulent infection, profound necrosis of tissue and bone involvement are contraindications to the tannic acid treatment.

*Elastic Adhesive Plaster Treatment.* Two pieces of elastic adhesive plaster, one over the other are applied, so that the bedsores and the skin surrounding it for at least an inch is covered. If the sore has a greater diameter than the elastoplast, two pieces may be laid side by side and held together by two pieces placed at right angles. It is left in position as long as it will adhere,

usually twelve to forty-eight hours. This is repeated until healing is complete. On removal of the bandage no attempt should be made to clean the surface of the ulcer. Wipe away the discharge from the surrounding skin and reapply the adhesive. Cardy rationalizes his treatment as follows: (a) the discharge does not readily soak through; (b) the two layers plus the discharge over the ulcer serve as an effective cushion protecting the granulations by distributing pressure; (c) where incontinence of urine or feces is present the ulcerated surface is less readily contaminated. Usually the patient complains of itching under the bandage and much attention is required to keep the patient from scratching the bandage off. However, it is never so pronounced as to demand discontinuance of treatment.

*Insulin and Parathyocresol Treatment.* Five units of insulin are given three times daily before meals. Sterile gauze saturated with parathyocresol in 1:10,000 solution is applied directly to the bed of the ulcer, tucked in under overhanging edges and saturated three times daily. At the end of forty-eight hours, normal saline solution is substituted for the parathyocresol. This alternation is continued at intervals of two days until the patient is discharged. The trade name for parathyocresol is sulphen.

Adjunct treatment consists of clipping away sloughs and opening and draining pus pockets. In extremely bad sores accompanied by much suffering, arrange a continuous bath, which is kept clean by continuous overflow and refilling and at a constant temperature, controlled by a thermostat. Perfect drainage and relief from pressure are thus augmented.

Other forms of treatment which have been suggested are: For surface stimulation:

|                      |               |
|----------------------|---------------|
| Argent. nitric.....  | 1.0           |
| Balsam of Peru.....  | 10.0          |
| Ung. Zinc Oxide..... | qs. ad. 100.0 |

To produce a dry gangrene, use thymol iodide-ferrous sulphate as a dusting powder.

## SUMMARY

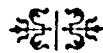
A brief resume is given of the various types of bedsores and their etiology, pathology and symptoms are discussed.

Three definite plans of treatment are described, namely: (1) tannic acid and heat treatment; (2) elastic adhesive plaster treatment; and (3) insulin and parathyrocresol treatment.

## REFERENCES

BRYNES, C. M. *Jour. Neurol. and Ment. Dis.*, 82: 373-380 (Oct.) 1935.

- CARTY, I. J. A. Treatment with elastic plaster. *Brit. Med. Jour.*, 1: 105-106 (Jan. 19) 1935.
- FANTUS, B. Therapy of the Cook County Hospital. *J. A. M. A.*, 104: 46-48 (Jan. 5) 1935.
- KEEN'S Surgery. Philadelphia, W. B. Saunders & Co., 1909, Vol. 1, pp. 333-338.
- LATIMER, E. O. Treatment with tannic acid. *J. A. M. A.*, 102: 751-752 (March 10) 1934.
- Nelson's Loose Leaf Living Surgery. Thomas Nelson & Son, 1927, Vol. 1.
- POWERS, J. H. Insulin and thyrocresol. *Clinical Misc. Mary I. Bassett Hospital*, 2: 45-52, 1935.
- TRUMBLE, H. C. Skin tolerance for pressure and pressure sores. *Med. Jour. Australia*, 2: 724-726 (Nov. 29) 1930.



# GAS GANGRENE

PHIL THOREK, M.D.

Associate Attending Surgeon, Cook County Hospital and American Hospital of Chicago

CHICAGO, ILL.

**S**URGEONS and medical men in general have become "anaerobe minded" since the World War. It was during this time that gas gangrene infections were first frequently encountered. The severity of the symptoms associated with such a high mortality and morbidity stimulated a rather concentrated study of the condition by clinician, bacteriologist and surgeon alike. Many questions have been answered and many still remain unanswered, however, we now have at least a logical attack to the problem and therapy has become quite standardized. This in itself is a tremendous stride forward and it behooves us to be abreast with the knowledge acquired especially in the last decade or two.

## BACTERIOLOGY

Originally gas gangrene infections were thought to be due to one specific organism, namely *Bacillus aerogenes capsulatus* of Welch but Weinberg and Seguin demonstrated that this concept was erroneous. They stated that there are many other anaerobes which include *Bacillus edematiens* or *vibrio septique* of Pasteur, *oedematiens novyi*, *Bacillus histolyticus* of Weinberg and Seguin, Vincent's bacillus, fusiforms, etc., which are capable of producing the same disease. The part played by *Bacillus coli* and anaerobic cocci seems to be that of a forerunner in that they prepare the tissues for the development of the disease. This is still a mooted question.

In daily practice we must have some simple concept of the bacteriology which confronts us, hence, we may simplify matters by stating that only five of the anaerobic bacilli are of importance to the surgeon, four of which belong to the gas

gangrene group and the remaining one being the tetanus bacillus. Each produces a powerful exotoxin which may be neutralized by proper anti-sera. All five are Gram positive bacilli and practically all of them are spore formers, therefore, they have been given the generic term "Clostridia" by the nomenclature committee of the Society of American Bacteriologists. We may discuss the five as follows

*A. Clostridium Welchii*. This is the commonest and most important variety. It is universally present in the intestinal tract of man and most animals, just as is *Bacillus coli*, but since it has the ability to form spores it may survive for a long period of time outside of the body in such habitats as fertilized soil and street dirt. The filth of trench life and contamination of gunshot wounds with soil and clothing explains its frequency during the last war. If found in a wound with no signs of activity, we consider it a saprophyte. This may become pathological only when large numbers are introduced and foreign bodies are present in an environment where considerable tissue destruction exists, especially muscle.

*B. Clostridium novyi*,

*C. Clostridium oedematis maligni*,

*D. Clostridium sordelli*.

These three listed organisms may be considered and discussed together. Clinically, it is quite important that these anaerobes be differentiated from *C. Welchii* and from one another. Such differentiations may be made by noting their cultural characteristics and response to specific antitoxins. They are all gas formers with resultant gangrene and may be found with *C. Welchii* in a given wound, but in the absence of the latter the involved area is more edematous and less gaseous. Isolation

and cultivation from the blood stream is possible only preterminally or after death.

*E. Clostridium Tetani.* The distribution of this anaerobe is similar to that of the gas gangrene organisms being found less often in the human intestinal tract than *C. Welchii* but being quite common among persons in contact with horses and cattle. Wounds which have been exposed to fertilized soil, street dirt and the like must therefore be suspected of possible contamination with *C. tetani* and its associated bacteria. Unlike the gas gangrene organisms it does not invade the body but remains in its site of entrance and there produces a toxin which has a definite affinity for nerve tissue. This has its clinical significance and we will refer to it in the discussion of treatment.

#### PATHOLOGICAL PHYSIOLOGY

The course of events that follows here is not constant, since such variables as the patient's resistance, the virulence of the organisms, blood supply, amount of muscle destroyed and the presence of foreign bodies all tend to modify the cases as seen. However, an understanding of this perverted physiology will help to clarify and explain many objective and subjective findings which we may encounter.

The spread of the disease is chiefly in the muscles rather than the fascial planes. Secondary foci of infection are at times found, their avenues of extension usually being the lymph streams. Generalized blood stream infections and involvement of serous surfaces have been recorded.

The production of gas is explained by the fact that the glycogen of living muscle is converted after death into dextrose and isomaltose (Henry), which are fermented by *B. aerogenes capsulatus* and allied organisms. The gas itself is non-toxic but due to its pressure an occlusion of the surrounding vessels is produced with a resulting ischemia. The toxins formed damage the adjacent blood vessels causing additional thrombosis and rupture. The muscle

cells become soft and mushy and a color alteration takes place. When ecchymosis is the predominating factor the muscle bundles assume a dark brownish-red color, but when necrosis predominates the color assumes its typical brick red or salmon appearance. The body apparently has difficulty in mobilizing its usual forces of resistance. This is borne out by the lack of leucocytosis and the absence of leucocytic infiltration. In its place we usually find an extensive serous exudation with a marked edema far out of proportion to the degree of infection. Spread is rapid, putrid abscesses with their characteristic brownish fluid and sickening odor appear and finally the toxins gain access to the blood stream causing a rapid exitus by paralysis of the medullary centers.

#### HISTORY

The anamnesis usually reveals the source of contact with the organisms. Injuries which occur in streets and around filth associated with foreign bodies, clothing, missiles, etc., must always be regarded as potential gas gangrene infections especially if the wound penetrates deep and involves the musculature. The condition may make its appearance following surgery if it is immediate and following an amputation of a diabetic or arteriosclerotic extremity or it may be delayed and following some simple plastic operation. The latter two instances again emphasize the part played by traumatized tissue and impress us with the fact that no typical sequence is a necessary prerequisite.

The initial symptom is usually pain or an increase in the intensity of a pre-existing pain occurring eighteen to twenty-four hours after the injury. The picture from this point on follows a rather stereotyped pattern.

Physical examination reveals an exceedingly sick patient showing signs of marked prostration, restlessness and apprehension. The expected malar flush seen with most pyogenic infections is replaced by a striking

pallor. The temperature rises and may reach a height of 103 to 105 degrees. The pulse rate quickly ascends and in the early stages the tachycardia far exceeds the rising temperature. The amplitude of the pulse becomes steadily smaller with a corresponding drop in blood pressure. Circulatory collapse may be so marked that an internal hemorrhage is at first suspected. At first blush the clinical picture seems to be out of proportion to the local injury.

Inspection of the wound reveals discoloration but not the typical picture of an acute inflammation. The redness is dusky rather than scarlet and the surface temperature shows no apparent increase, in fact we are quite surprised to find that the limb, distal to the involved area, becomes progressively cooler as its circulation becomes impeded. As the edema spreads the overlying skin becomes blanched and raised vesicles appear and, if infected, inspection reveals frank gangrene with sloughing necrotic tissue. If gentle pressure is exerted on the margins of the wound, a sanguinopurulent exudate containing gas bubbles makes its appearance. The discharge usually has a foul odor suggestive of putrescent meat. Early in the course of these infections it is difficult to detect the presence of gas, however, the best means of determining its early presence is by auscultatory percussion. Gas in any appreciable amount transmits a sensation of crepitation to the palpating hand which cannot be mistaken. An x-ray film will frequently demonstrate gas in the tissues even before auscultation or palpation. The rapidity with which these changes occur and the associated high mortality, makes early diagnosis and immediate treatment imperative.

#### TREATMENT

If we could constantly keep in mind the difference between a soiled and an infected wound the incidence of gas gangrene could be reduced to a minimum. The differential diagnosis of these two lesions is at times simple if we consider such factors as: the

environment in which an accident occurred, amount of gross soiling in the wound, duration of a recent injury or pre-existing disease, blood supply and finally the condition of the soft tissues especially muscles, as to its color, contractibility and ability to bleed. Once the condition has started there is but one treatment and that is surgical. This may be in the form of massive debridement associated with multiple incision extending into normal tissue or, in advanced cases, immediate, high amputation. The use of a tourniquet is to be discarded. The resulting wounds, be they linear incisions or a guillotine amputation stump, should be left wide open to permit the entrance of oxygen and to encourage the drainage of any noxious exudate. They should be frequently irrigated with 50 per cent peroxide and then loosely packed with 1 per cent potassium permanganate. These dressings should be changed often and kept saturated.

Serum prophylaxis and serotherapy is at present accepted. Ivens believes that the polyvalent sera have definite prophylactic value. The prophylactic dose of gas gangrene antitoxin in conjunction with tetanus antitoxins is now available. It contains 15 units of tetanus antitoxin, 10 units of perfringens antitoxin and 10 units of vibron antitoxin. In the active serotherapy we use a polyvalent serum containing 4000 units of tetanus antitoxin, 15,000 units of perfringens antitoxin, 35,000 M.L.D. of vibron antitoxin and 20,000 M.L.D. of histolyticus antitoxin per 100 c.c. of saline; 200 c.c. is given immediately before or after operation followed in four hours by an additional 100 c.c. The marketed commercial products may be given intravenously or intramuscularly, preferably the former. To prevent anaphylactic reactions some authorities advise diluting the serum with 500 c.c. of normal saline and giving it subcutaneously. The amount to be used and the frequency of administration can only be determined by the patient's condition and his response to treatment. Although

at present the consensus of opinion is that these sera are of definite value, both prophylactically and therapeutically, it must be remembered that they by no means supplant surgery and are used only as adjuncts to the scalpel.

Ether and chloroform anesthesia should be avoided since they tend to produce an acidosis which favors the infection. If an amputation is decided upon, spinal is the anesthesia of choice, however, linear incisions may be accomplished with local infiltration or nitrous oxide inhalation.

General supportive measures and symptomatic treatment should be instituted in conjunction with the therapy as outlined. Finally, a constant vigilance should be kept for the development of a probable acidosis which must be immediately combatted by proper forms of alkalization. Discussion concerning the utilization of charcoal, rivanol, Pilcher's solution, oxygen injection into the tissues and x-ray therapy has been intentionally avoided since their efficacy as therapeutic aids awaits further and more detailed reports.

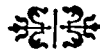
#### SUMMARY

The outstanding highlights, when we consider the subject of gas gangrene, may be listed as follows:

1. An understanding of the bacteriology and its clinical application;
2. The picture of a patient whose critical general condition is out of proportion to his local lesion;
3. The differential diagnosis between a soiled and an infected wound;
4. The early demonstration of crepitus by either palpation, auscultatory percussion or x-ray;
5. The immediate institution of proper therapeutic measures.

#### REFERENCES

- BERGEY, D. H. *Manual of Determinative Bacteriology*, Ed. 3. Baltimore, Williams & Wilkins Co., 1930.  
 CHRISTOPHER, F. *Textbook of Surgery*. Philadelphia, W. B. Saunders Co., 1936.  
 LEWIS, D. *Practice of Surgery*. Hagerstown, Md., W. F. Prior Co., 1933.  
 MILCH, H. *Ann. Surg.*, 93: 1220 (June) 1931.  
 MILLER, W. M. *Surg. Gynec. and Obst.*, 54: 232 (Feb.) 1932.  
 WEINBERG and SEGUIN. *La Gangrene Gazense*. Paris, Masson et Cie, 1915.



# BLOOD TRANSFUSION

JOHN M. SCANNELL, M.D., F.A.C.S.

Attending Surgeon, Mary Immaculate and St. Catherine Hospitals

JAMAICA, N. Y.

THE object of this paper is to discuss some of the more important practical problems associated with the procedure known as whole blood transfusion.

It is not necessary to enter into a discussion of the life-saving therapeutic value of properly matched whole blood as the literature on this for the past twelve years is very convincing.

## SELECTING A DONOR

The first important step in a successful transfusion is the selection of a proper donor, and although this part of the procedure is better than it was ten years ago, many serious mistakes are still being made causing deaths and lawsuits.

The wrong way to select a donor is to use a friend or relative just because his blood matches with that of the patient's. Many recipients have been infected with syphilis by this procedure.

It is wrong to place the responsibility of the blood matching in the hands of internes unless they have had special training in this work.

It is wrong to use the so-called universal donors without doing a complete cross-matching. The right way to choose a donor is to do a Wassermann or Kahn blood test on him before the transfusion, and a physical examination. A short history is taken. Be sure to ask about tuberculosis, malaria and venereal diseases. Hemoglobin estimation should show at least 80 per cent.

## BLOOD TYPING OR GROUPING

This is not necessary but is of value in saving time when sending for a professional donor.

Many errors are made in typing bloods due to the fact that diagnostic sera becomes inactive; this is the reason why so many

people are placed in Group o. My own blood was typed three times before it was properly classified; the first time I was put in Group o when as a matter of fact I belonged in Group A.

It must also be remembered that although patient's and donor's blood belong to the same group, they may not match.

Every individual should know to what group his blood belongs as this often saves much valuable time and may save a life.

## BLOOD GROUPS

| BLOOD GROUPS       |   |         |   |
|--------------------|---|---------|---|
| International Moss |   | Jansky  |   |
| AB same as         | 1 | same as | 4 |
| A same as          | 2 | same as | 2 |
| B same as          | 3 | same as | 3 |
| O same as          | 4 | same as | 1 |

The International classification is the one in common use.

## BLOOD MATCHING

It is important that complete cross-matching of the bloods of the recipient and the donor should be done before selecting a donor for transfusion. No short cut methods should be employed and if there is any question about the reactions the test should be repeated.

One often hears that it is only necessary to mix the recipient's serum with a solution of the donor's cells and if no agglutination occurs they match. This is wrong and many serious reactions have occurred when this method was used.

## PERFECT BLOOD MATCHING

This is one in which the recipient's serum and a 5 per cent normal saline solution of donor's cells are mixed together on a glass slide in sufficient quantity (0.5 c.c.) so that they will not dry out in one hour.

This slide is allowed to remain at room temperature for a period of thirty minutes; if no agglutination of the red cells occurs proceed to complete the cross-matching by repeating this test using another slide with a 5 per cent normal saline solution of recipient's cells and donor's serum. If there is no agglutination of the red cells on this slide the bloods match, and it is safe to use this donor. This test appears to be very simple but many errors are made, e.g.:

1. Drying out of the slides gives one the picture under the microscope of agglutination.

2. Do not put the slides in an incubator; it is not necessary and may cause the slide to dry out.

3. Do not put the slides in an ice box; it will hasten the reaction but may cause false agglutination.

4. Rouleaux formation of red cells is often taken for agglutination.

5. False agglutination is one in which the red cells group together but the cells remain intact. This can be determined under the high power lens of a microscope.

6. In large transfusions where two donors are going to be used in the same transfusion their bloods should be matched against one another in addition to matching them to the blood of the recipient.

Drying out of solutions can be prevented by the use of hanging drop slides. Also, much smaller amounts of solution can be used. Put a little vaseline around the rim of the depression in the hanging drop slide before putting on the cover glass containing the solution.

#### CLINICAL MATCHING

In an extreme emergency where a blood transfusion is needed at once, send for a donor whose blood belongs to Group o and his history and physical examination shows that there is no reason to believe he is suffering from tuberculosis, lues or malaria.

Inject 10 c.c. of his blood into a vein of the recipient and then wait two minutes; if no reaction occurs inject 20 c.c. of blood into the recipient and if after waiting two

minutes no reaction occurs it is safe to proceed with the transfusion. If a reaction occurs discontinue the transfusion at once.

#### SYMPTOMS OF REACTION

Feeling of distress, dyspnea, chill, cyanosis, headache, pain in the back, precordial pain, convulsions and collapse; if anyone of these symptoms occur or a combination of them, it is called a reaction.

#### EXSANGUINATION-TRANSFUSION

This procedure is indicated in severe toxemia, e.g., following extensive third degree burns, uremia, carbon monoxide and metallic poisonings.

It is necessary to obtain a donor who can afford to lose 1000 c.c. of blood, or it is better to have at least two donors ready.

A No. 18 gauge needle is first inserted into the median vein of the donor and salt solution injected through this to remove any blood from its lumen. Under local anesthesia the saphenous vein just below Poupart's ligament is exposed and a No. 16 gauge cannula is inserted through this vein into the femoral vein; then, by means of the apparatus which will be described later, 1000 c.c. to 2000 c.c. of blood are removed. The amount taken will depend upon the reaction of the patient, as the blood is removed and the blood pressure of the recipient is lowered the first symptoms of danger as a rule are nausea and vomiting. When this occurs it is well to stop the exsanguination and begin the transfusion at once.

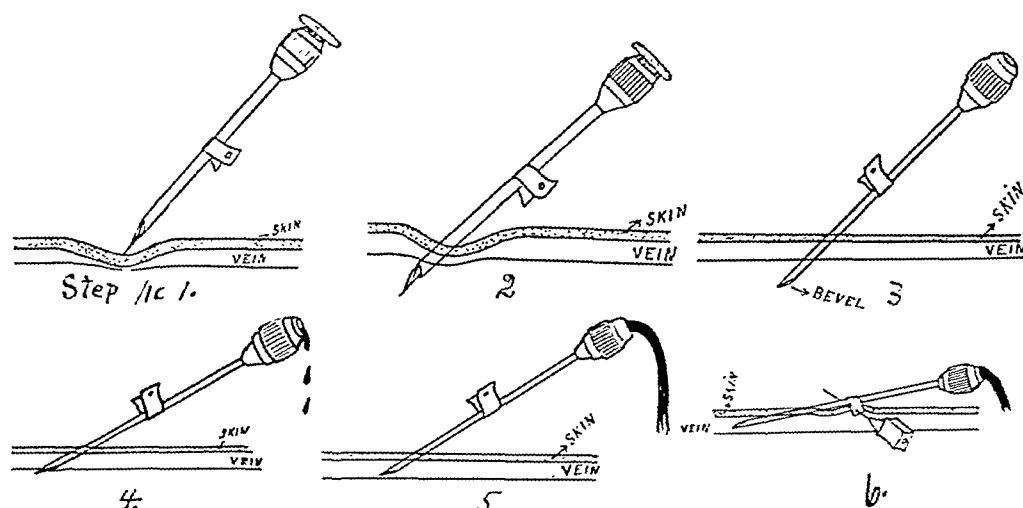
#### INSERTING NEEDLES OR CANNULAS INTO VEINS

One of the most troublesome and difficult parts of the technique in doing a blood transfusion is the inserting of the needles without cutting down on the vein. The reason for this difficulty is because we use comparatively large needles, and veins vary so much in size and in the thickness of their walls.



The needles we recommend and always use were devised by Dr. R. W. McNealey of Chicago. These needles can be locked to

can feel the end of the needle snap into the lumen of the vein, blood will now flow freely from the head of the needle. The



FIGS. 1-6. Inserting transfusion needles.

the skin and cannot pull out during the transfusion. No. 18 gauge is the size most commonly used. It is important to sharpen these needles before the transfusion and protect the points from injury while they are being sterilized.

The method I use to insert a blood transfusion needle follows:

After a tourniquet is placed around the arm a drop of 1 per cent procain is injected over the most prominent vein in the region of the elbow.

The vein is then stabilized by holding it between the left thumb and index finger and a No. 18 gauge McNealey needle is then pushed directly through the middle of the vein. It is very important that the needle pass through the middle of the vein; if not, the point will not slip into the lumen of the vein later when it is withdrawn. (Steps 1 and 2.)

Step 3. The needle is rotated around so that the bevel is now pointing down and the inner sharp cannula is now removed.

Step 4. Slowly withdraw the needle until blood begins to drop from the head of the needle; at this point the bevel is riding through the posterior wall of the vein.

Step 5. Very carefully and slowly withdraw the needle just a little more and you

needle is then pushed well into the vein and connected to the apparatus.

Step 6. With a fine, 25 gauge hypodermic needle lock the needle to the skin.

*Very Important.* Always insert needle into the donor first. Failure to do this has caused deaths and serious infections to many innocent donors.

It does not make any difference which way the needle points in the donor, but it always should point towards the shoulder in the recipient.

#### FONTANEL PUNCTURE IN INFANTS

The practice of transfusing blood through the anterior fontanel should, in my opinion, be condemned, because one is not always certain that the needle passed through the fontanel will lie wholly within the sinus during the transfusion.

In infants, I always use either the median basilic or median cephalic vein and insert a small needle or cannula.

#### THE APPARATUS

A blood transfusion apparatus should be simple and accurate in construction and so designed that a physician unassisted can perform a transfusion successfully.

The operator should have absolute control of the flow of blood at all times, for that

reason any apparatus with automatic valves should be condemned.

All connections should be locked in such

putting in the sterilizer lubricate the piston and inside of the cylinder with mineral oil or white vaseline and wrap each one

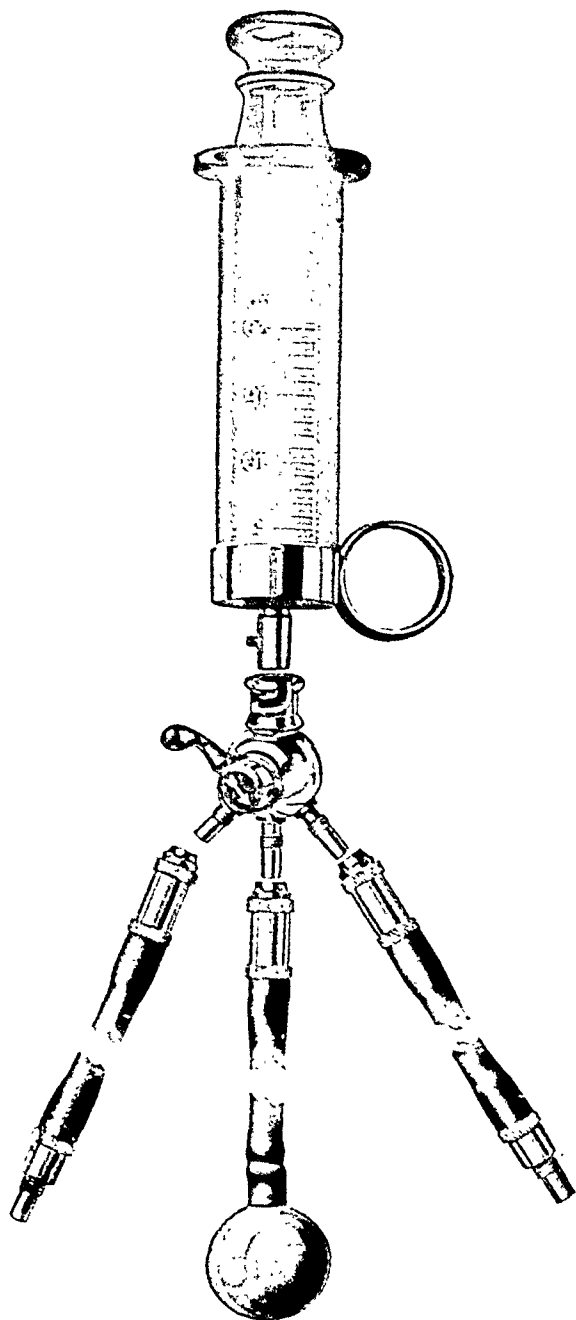


FIG. 7. The Scannell transfusion apparatus.

a way that it is impossible for them to come apart during the transfusion.

There are no sharp corners or dead spaces in the apparatus where blood can stagnate and clot.

#### SYRINGES

These are made especially for transfusions with a large opening at the tip and the pistons fit accurately and tightly. Before

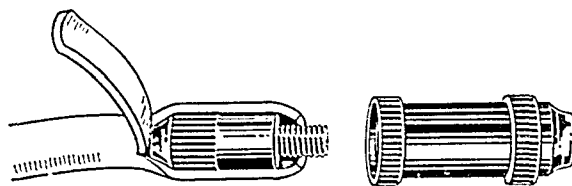


FIG. 8. Rubber tubing and metal connections locked together.

separately in gauze or a towel. Enough of the vaseline will remain to lubricate the syringe.

#### VALVE

This is a precision instrument and made with a great deal of care and accuracy and

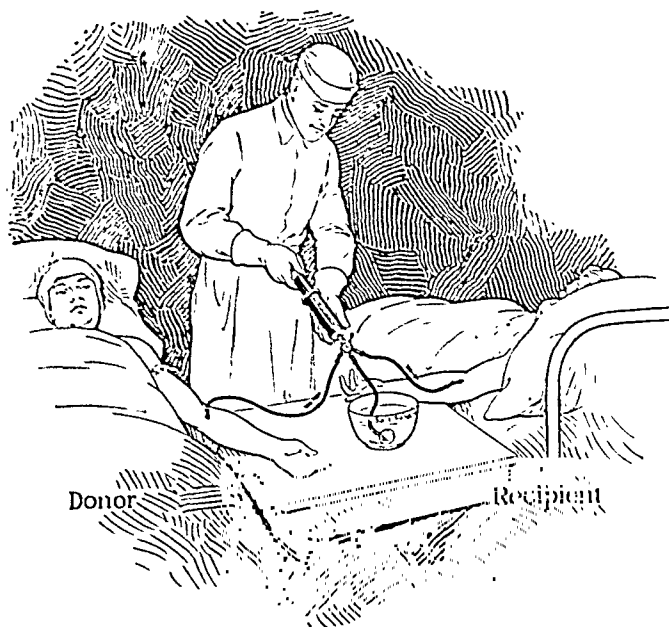


FIG. 9. Whole blood transfusion.

should be handled carefully. After every transfusion wash it with ether and lubricate it with a fine grade of light machine oil.

#### RUBBER TUBING

After trying many varieties including transparent tubing, I prefer to use a good grade No. 20 F. urethral male catheter; the ends are cut off and locked in the following manner to metal connections:

## TRANSFUSIONS

After inserting the needle in the vein of the donor, connect one of the side tubes coming from the valve to this needle. Loosen the tourniquet around his arm and draw up 10 c.c. of saline solution through the middle tube and inject this into the donor to determine if the point of this needle is resting wholly within the lumen of the vein. This procedure is again repeated after the needle or the cannula is inserted into the recipient.

Hold the syringe in the left hand in such a way that the valve handle can be turned readily with the left thumb and start the transfusion.

If the syringe fails to fill, the point of needle is not in the donor's vein or the tourniquet around his arm is too tight.

If at any time during the transfusion the piston begins to stick turn the valve-handle until the arrow points to the outlet to the basin of salt solution and wash the syringe out two or three times. Also wipe off the upper part of the piston with a piece of gauze wet with saline solution. At the conclusion of the transfusion wash and clean the apparatus at once; this is done by forcing plain water through the apparatus several times, then peroxide of hydrogen, plain water again, and finally ether.

Any one who expects to do blood transfusions successfully should not only own, but also take personal care of his apparatus.

## CUTTING DOWN ON A VEIN

If this becomes necessary make a small transverse incision over the site of the vein. The vein is dissected free and held out of the

wound by two pieces of fine catgut or silk one above and one below. A V-shaped incision is made in the vein by means of a cataract scissors; a cannula is then inserted and tied into the vein by the upper piece of catgut.

TRANSFUSION OF CADAVER OR  
CONSERVED BLOODS

The reports from Moscow stating the success they have had using cadaver and conserved bloods in a transfusion have been received in this country with a great deal of interest. Without going into a discussion of this, which would be rather lengthy, it is evident that blood of this nature is much different than fresh live blood.

A review of the literature on this subject, some of which comes from Moscow, definitely concludes that the transfusion of fresh, whole blood is still the one of choice.

## CONCLUSIONS

1. Fresh whole blood which is compatible has life-saving therapeutic value.
2. The prerequisites for donors are:
  - A. Freedom from syphilis, malaria and tuberculosis;
  - B. A red blood cell count of 4,000,000 and a hemoglobin of 80 per cent;
  - C. Complete and accurate cross-matching.
3. Successful blood transfusions are dependent upon:
  - A. Perfect instruments or apparatus;
  - B. Accurate knowledge of the technique in all its details;
  - C. Practice in its performance.



# INTRAVENOUS INFUSIONS

HENRY C. FALK, M.D., F.A.C.S.

Clinical Professor of Gynecology, New York University College of Medicine; Director of Gynecology, Harlem Hospital; Gynecologist, French Hospital

NEW YORK

**W**ATER loss and its replacement bring under one head a variety of disease entities, such as, diabetic ketosis, small intestinal fistulas, massive burn of the body and the postoperative surgical case. All of these conditions, although they have no clinical similarity, have water loss as a common characteristic. The cause of this loss is not the same in each condition nor is it the sole expression of the disease; yet, the dehydration imposes a great handicap upon the patient and its neglect becomes an important factor in the morbidity and frequently is a major contribution to the mortality in critical cases.

Normally, 65 per cent of the total body weight consists of water distributed in the blood, intercellular and intracellular fluid. Fluid loss from the body is a constant and normal process. This normal fluid loss through the various orifices and the skin is about two to four liters per day. This loss in the normal individual is replaced by the ingestion of fluids and food, the quantity being regulated by the sense of thirst and hunger.

In the normal individual an excess of fluid, either in the blood stream or in the tissues, is rapidly excreted through the lungs in respiration, through the kidneys as urine, through the skin by invisible evaporation and perspiration and through the intestinal tract. This regulatory mechanism of water balance is one of the normal physiological mechanisms of the body. In various pathological conditions this mechanism can be disturbed and fluid loss may become a major factor in the disease.

Some of the important surgical conditions in which fluid loss plays an important role and in which the normal regulatory mechanism may be upset are:

1. Hemorrhage;
2. Shock—it is generally accepted that in this condition there is a marked loss of fluid from the vascular bed and its transfer to the tissue spaces;
3. Loss of fluid from the gastrointestinal tract, vomiting or diarrhea;
4. Loss of fluid from the gastrointestinal tract in small intestinal fistulas;
5. Loss of fluid into the gastrointestinal tract, as is frequently seen in intestinal obstruction and ileus;
6. Hyperpyrexia and marked perspiration;
7. Metabolic disorders, as diabetic ketosis; and
8. Burns.

In most of these conditions the loss of water is accompanied by an equivalent salt loss and in those conditions in which food must be withheld, the depletion of carbohydrates leads to incomplete fat combustion with ultimate ketosis.

In the therapy of these conditions there are several factors to be considered.

1. The condition producing the fluid loss;
2. The state of the individual's organs, gastrointestinal tract, heart, kidneys, liver, etc., and
3. The elements requiring replacement water, salt, or carbohydrate.

Following hemorrhage an infusion of saline should be given to make up for fluid loss in the blood stream. Saline introduced in this manner does not remain in the blood stream for any extended period of time. It should be used only as a temporary measure until a donor can be typed and the patient given a transfusion.

For the normal postoperative surgical case, Coller, Dick and Maddock<sup>1</sup> recom-

mend 1000 to 3000 c.c. of dextrose in distilled water as an infusion to make up for fluid loss and to prevent thirst and ketosis.<sup>1</sup> They have shown that the daily administration of 3000 to 3500 c.c. of saline and glucose intravenously caused a gain in weight in 12 of 13 surgical patients studied. This gain they attribute to the retention of water in the tissues as a result of chloride retention. The administration of glucose and distilled water caused no gain in weight and when administered to patients after the use of saline, caused a rapid loss in weight. The observations of these authors are true and accurate and agree with similar experiments in the past. Their conclusions however, can be questioned. The two facts, (1) that distilled water is a dehydrating agent and (2) that salt retention and water retention go hand in hand have long been known. That edema and water retention due to salt retention can be released by distilled water and glucose, shows the qualities of distilled water as a dehydrating agent and the underlying mechanism by which it acts. But to conclude from this that the treatment of dehydration is by administering distilled water, e.g., a dehydrating agent, seems somewhat questionable.

It would appear that the best fluid to give the "normal surgical patient" who is dehydrated should be water which can be retained, e.g., saline. The carbohydrate is given to combat ketosis and the saline to make up the lost fluid and chlorides. If large quantities of fluids over long periods of time are required, one is no longer dealing with the "normal" postoperative surgical patient, in which case other factors would enter to govern the type of intravenous fluid required. The giving of intravenous saline in quantities of 3500 c.c. or more, daily, to a normal patient, with normal fluid losses of approximately 2000 c.c. daily, would of necessity, cause a salt and water retention.

In cases with severe vomiting or diarrhea, or with small intestinal fistulas or intestinal obstruction, the fluid loss can

amount to 3000 c.c. per day. This loss must be made up; it consists not only of water but also of chlorides. These patients should receive 4000 to 6000 c.c. of 10 per cent dextrose in saline or Ringer's solution, the dextrose as a food and the saline and Ringer's solution to supply the lost chlorides. The administration of glucose in distilled water to these patients adds to the loss of chlorides, as the water is not excreted as  $H_2O$ , but as a dilute salt solution, thus increasing the chloride deficiency. Hartwell and Hoguet<sup>2</sup> have shown experimentally in dogs that where there is a marked loss of chlorides and fluids by vomiting, as in cases of high intestinal obstruction, these animals could be kept alive for a considerable period of time by the administration of sufficient quantities of saline solution intravenously. Particularly in those cases of intestinal fistulas where the lost salts, other than sodium, become a factor, Ringer's solution is used alternating with the saline infusion. In this way the salts of sodium, calcium and potassium are supplied.

Many authorities lay great stress upon the dangers of right heart failure due to massive infusions. In an individual with a good cardiac reserve the danger does not lie in the quantity of the fluid administered, but rather in the rate of introduction. The circulation can readily accommodate itself to 200 to 300 c.c. of fluid an hour. When glucose solutions are given it has been found that the high rates of flow raise the blood sugar above the kidney threshold and causes a glycosuria with its attendant water loss. Fantus<sup>3</sup> states that "a 10 per cent solution (of dextrose) can be introduced at the rate of 500 c.c. an hour before the sugar tolerance of the average individual is overcome, as evidenced by leakage of sugar in urine."

The nutritional requirements of the average patient is approximately 2000 calories per day. To supply this with intravenous glucose is rather difficult because 1000 c.c. of 10 per cent glucose solution contains but 100 grams of dextrose and one gram of dextrose yields about 4 calories, so

that 3000 c.c. of 10 per cent solution would yield only 1200 calories. If one depends entirely upon the parenteral fluids for the nutritional requirements of the individual the more concentrated solutions should be used, such as 25 per cent dextrose solution.

In subacute or chronic conditions, cases of hyperpyrexia, marked perspiration, burns, metabolic disorders, ketosis, diabetic and otherwise, where the gastrointestinal tract is intact, fluid can be taken by mouth or rectum in the form of weak salt solution. If however, these routes cannot be utilized or are inadequate, fluids must be administered by the parenteral route either subcutaneously, hypodermoclysis, or intravenously, phleboclysis.

Hypodermoclysis may be used to supply a limited need for a short period. Owing to its attendant discomfort, the uncertainty of its absorption, the dangers of infections and sloughing, particularly when dextrose is used, and its quantitative limitations when fluids must be administered for a prolonged period, hypodermoclysis is gradually giving way to phleboclysis or infusion. Infusions overcome most of these disadvantages. However, the use of phleboclysis has frequently been followed by severe reactions and for this reason many who would like to use the procedure hesitate to do so.

An analysis of the cause of these reactions, has shown that in the majority of instances they can be prevented by careful attention to details in the materials used and their preparation.<sup>4</sup>

The distilled water must always be freshly prepared and triple distilled in order to remove the pyrogenic substances and prevent their reappearance. Only C.P. anhydrous glucose and C.P. sodium chloride should be used. Great care must be exercised in the weighing and transmission of the powder to the solvent so that no foreign material is introduced. The weighing machine, containers and all materials coming in contact with the powders must be scrupulously clean.

The hydrogen ion concentration of the solution must be fixed. The hydrogen ion

concentration of the blood is fairly constant at a pH 7.4. Williams and Swett<sup>5</sup> have shown that a 10 per cent glucose solution changes its pH from 6.20 to 5.17 by boiling for twenty minutes. They have also shown that a glucose solution standing in a container in the laboratory for twenty-four hours changes its pH from 6.60 to 5.15. They believe there is a definite relationship between the hydrogen ion concentration of the injected fluid and the post-infusion reaction.

The reactions caused by variations in the pH of the injected fluid can be prevented by:

1. Injecting the fluid into the blood slowly so that the blood will have time to neutralize the fluid introduced;
2. Adding a buffer solution to the fluid to be injected;
3. Using only fresh solutions whose pH is known; and
4. Using solutions placed while fresh into vacuum containers. So long as a vacuum is maintained and the fluid does not come in contact with the external air its hydrogen ion concentration does not change.

Any solution, distilled water, saline or glucose, that is in contact with the external air is constantly undergoing some changes; pyrogenic substances develop, pH values change or carbonic acid is absorbed from the air. Any one of these may produce reactions. Solutions kept in open containers must therefore be used only if fresh. All flasks must therefore be dated and discarded when they are one week old.

The glass used throughout the distillation and as permanent containers must be hard, such as pyrex. It must be an alkali-free glass and scrupulously clean from all foreign material. The filter paper used must be of the best type so that there are no loose fibres which might be transmitted into the filtrate. The fluid should be filtered three times. The gauze, so often used as stoppers, frequently causes the appearance of lint in the solutions. To prevent this, pure gum sheeting may be

used or an inverted beaker makes a very good cover.

Improper sterilization of the rubber tubing is probably one of the most frequent causes of reaction. New tubing may be used without having had the talcum coating washed away; the tubing may have been sterilized by boiling in a soda solution in which case some of the solution may remain on the inner side of the tubing; sediment in the bottom of the sterilizer may settle in the tubing; some forms of tubing contain sulphur which when precipitated clings to the inner side of the tubing; any of these substances if washed into the blood stream may cause a reaction. The best tubing to use is made of pure gum. Between cases the tubing must be carefully washed, thoroughly rinsed inside and out with triple distilled water, and then packed in gauze and sterilized in the autoclave.

The Sloane Hospital for Women recommends the following: (1) Soak all new tubing in soap and water for one hour, (2) wash well with soap and water, (3) wash in running water, (4) soak for six hours in 4 per cent solution of sodium hydroxide, (5) wash well in running water, (6) wash well in distilled water. Pack and sterilize in the autoclave.

Some authors seem to lay too much stress on the temperature of the injected fluid. The exact temperature of the fluid when it reaches the patient is difficult to state. Excessive heat may cause the liberation of fibrin thus causing a reaction. Excessive cold should not be allowed. The best temperature is about room temperature. If the fluid in the container is warm and it is allowed to flow through the needle slowly enough, it will automatically regulate the temperature. Some recommend the use of a hot water bottle or an electrical heating apparatus around the tubing but this is usually unnecessary.

In sterilizing dextrose solutions caramelization of the dextrose may take place if the heat is excessive or extended over too long a period. This causes the solution

to become light yellow or brown. *Any dextrose solution that is not crystal clear should not be used.*

All flasks, tubing, needles, etc., used, either in transporting or administering the infusion should be carefully washed before each infusion. Any old blood either in the needle or in the tubing will cause a reaction. All parts should be boiled for five minutes in a 0.1 per cent sodium hydroxide solution, then soaked in distilled water to remove the hydroxide and following this, they should be washed in triple distilled water, then assembled and sterilized in the autoclave.

In order to prevent reactions from infusions, the proper approach for the sterilization, preparation of the materials, etc., require that a separate room be provided for this purpose only. The management of this room must be placed in the hands of competent and reliable nurses whose sole duty shall be the cleansing, preparation and sterilization of the various materials and tubing used for infusion. This is expensive and cannot be carried out in smaller institutions.

It seems that our present situation with regard to infusion solutions resembles the situation which existed when the hospitals used to prepare, chromicize and sterilize their own catgut. Uniformity of results were not obtained until commercial houses began the manufacture of catgut. They, with their expanded facilities, were able to produce a uniform sterile product at a moderate price. There seems to be no reason why the saline, glucose and other intravenous solutions used for phlebotomy should not be prepared in quantities and sold to the hospitals at a moderate cost. The various institutions could demand a stable product without pyrogenic substances, in hard glass containers, properly stoppered or sealed so as to maintain the vacuum. The tubing and needles could also be supplied in quantities. The expense of maintaining an infusion room and unit in the hospital would more than cover the cost of buying a commercial product.

## DETAILS OF TECHNIQUE

In most institutions the giving of an infusion is regarded as menial work and is

the personal attention of a more experienced member of the interne staff.

The veins generally used are the median

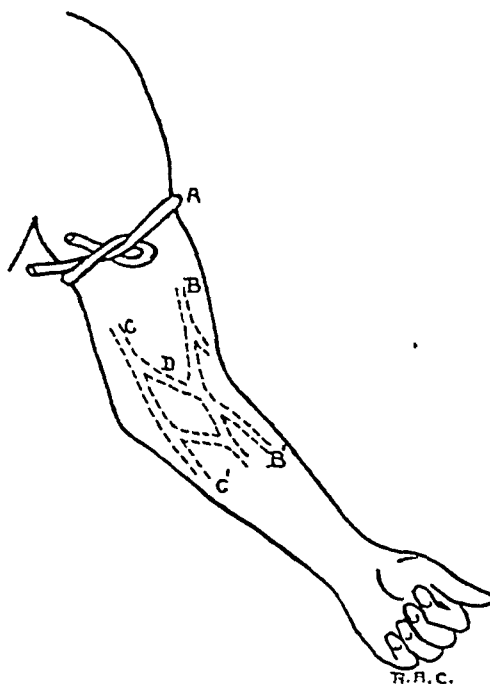


FIG. 1.

FIG. 1. Proper method of applying piece of rubber tubing as tourniquet to arm for purposes of distending veins at bend of elbow and usual distribution of superficial veins in antecubital fossa. Rubber tubing A is tied only sufficiently tightly about the arm to occlude venous return and not so tightly as to embarrass arterial blood supply. Note that the knot made by rubber tubing is in the nature of a slip-knot which can be released by simply pulling proper end of tubing; advantage of this is that release of tourniquet requires use of only one hand. Arm band of blood pressure apparatus makes an admirable tourniquet and presents especial advantage that pressure exerted by it can be controlled manometrically; accordingly, this device is offered merely as a substitute in case no blood pressure apparatus is readily available. Veins illustrated are B-B' cephalic vein, C-C' basilic vein, and D median cubital vein.

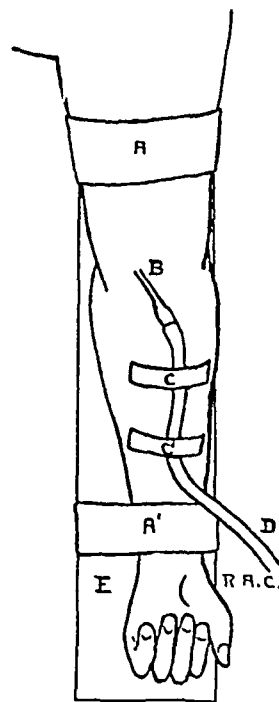


FIG. 2.

FIG. 2. Drawing illustrating technique of intravenous infusion. E is wooden board of suitable dimensions; it passes under back and shoulders of patient. A and A' are strips of adhesive plaster or layers of bandage which fasten arm and forearm to board. B is infusion needle which has been inserted into one of the antecubital veins. C and C' are strips of adhesive plaster which hold needle and rubber tubing D in permanent position. (Cutting, R. A. Principles of Preoperative and Postoperative Treatment. Paul B. Hoeber.)

usually assigned to the junior interne whose knowledge of asepsis, surgical technique, etc., is limited. As a result of this faulty arrangement, breaks in technique occur which allow foreign proteins, air borne bacteria, etc., to be introduced thus causing infusion reactions. As a rule patients requiring infusions are sick enough to have

basilic or cephalic veins. A tourniquet of soft rubber tubing is applied above the elbow. This distends the veins in the antecubital fossa and makes them visible or palpable. This tubing should be applied with a slip knot so as to be readily untied (Fig. 1). The pressure of the tourniquet should not exceed the blood pressure and



one should always be able to feel the pulse at the wrist. Some men prefer to use a blood pressure cuff which allows the pressure to be regulated to that of the blood pressure of the patient.

The field should be draped with sterile towels and the region over the veins sterilized with iodine 3.5 per cent and washed with alcohol. The operator should wash his hands and don sterile gloves.

The vein should be palpated and a fine needle, preferably a 22 gauge, attached to a syringe should be introduced into the vein. As soon as the needle enters the cavity of the vein some blood should be drawn into the syringe. The needle should be introduced for about 1 cm. into the vein. The syringe is removed and the glass tipped cannula from the reservoir is attached to the needle. Before doing so however, it is essential to have all the air out of the tubing. This is done by raising and lowering the cannula with tubing attached allowing the saline to displace all the air in the tubing.

*Continuous Infusion.* Some patients may require 5000 c.c. of fluid daily for several days. This requires a continuous flow of fluid into the veins throughout the twenty-four hours, if the rate of 200 to 300 c.c. per hour is maintained. When this is required, the arm or leg should be securely tied to an arm board and the needle fixed in the vein. Most men prefer cutting down on the vein and inserting a cannula directly into it and tying it there for continuous infusion. Matas<sup>6</sup> advises a cannula

with a terminal and lateral opening. In giving a continuous infusion, special care should be taken to maintain the sterility of the field, particularly when the vein is exposed by an incision.

### CONCLUSIONS

1. Water loss, or dehydration is an important factor in the morbidity and frequently a major contribution to the mortality in critical cases.

2. To overcome dehydration, water should be administered as saline solution.

3. To prevent reactions, a good commercial product with proper equipment should be used and all aseptic precautions should be observed in its administration.

4. Patients sick enough to require an infusion should have the attention of an experienced member of the interne staff.

### REFERENCES

1. COLLIER, F. A., DICK, V. S. and MADDOCK, W. G., Maintenance of normal water exchange with intravenous fluids. *J. A. M. A.*, 108: 1522, 1936.
2. HARTWELL, J. A. and HOQUET, J. P. Experimental intestinal obstruction in dogs with especial reference to the cause of death and the treatment by large amounts of normal saline solution. *J. A. M. A.*, 59: 82, 1912.
3. FANTUS, B. The prescribing of dextrose for phlebotomy. *J. A. M. A.* 102: 2165, 1934.
4. FALK, H. C. Common causes of reaction following use of intravenous solutions and their prevention. *New York State Jour. Med.*, 35: 480-484, 1935.
5. WILLIAMS, J. R. and SWETT, M. Hydrogen ion concentration studies. *J. A. M. A.*, 78: 1024-1026, 1922.
6. MATAS, R. The continued intravenous drip. *Ann. Surg.*, 74: 643, 1924.



# ACUTE LYMPHANGITIS

WILLIAM A. STEEL, M.D.

Professor of Principles of Surgery, Medical School of Temple University; Surgeon, Temple University Hospital

## PHILADELPHIA

**A**CUTE lymphangitis, popularly known as blood poisoning, usually follows a trivial skin break, spreads with dramatic rapidity and has a mortality of from 20 to 30 per cent. It involves, simultaneously, the superficial lymph vessels and glands and might be better termed acute lymphangio-adenitis. It is also spoken of as acute spreading cellulitis or streptococcic septicemia. The high mortality will be raised or lowered in proportion as the physician first consulted, appreciates the necessity for complete immobilization of a member in which red skin lines extend from a peripheral wound to a palpable, tender lymph node.

### ANATOMY

A knowledge of the anatomy of the lymphatic system will aid us in understanding the inflammatory reactions which occur when this circulatory body system is invaded by an infectious process. The lymph makes up one-sixth to one-third the weight of the entire body. It is a clear secretion resulting from the cellular activity of the tissues and every body cell may be considered as bathed in a sea of lymph. The lymph vessels emerge from the intracellular lymph spaces (Fig. 1) and constantly absorb whatever liquid is presented to them. These lymph vessels then run into and break up in the lymph glands. The glands detain foreign particles, bacteria, pathogenic cells, etc., and as far as possible destroy them. If the first lymph gland is unable to destroy infected matter some is carried to the next series of nodes which do what they can to complete the work. Thus the lymph nodes are the great system of defense in peripheral infection. If the bloc against spreading infection is success-

ful, the invaded gland may resolve or break down into an abscess. If the bloc is unsuccessful, the infected matter enters the receptaculum chylae, passes through the thoracic duct into the subclavian vein and a general blood stream infection or septicemia results. Further filtering by the lymph glands of the infection in the blood stream may result in a general adenopathy. The lymph vessels also carry fluid from the serous cavities and chyle from the alimentary tract.

The subject of acute lymphangio-adenitis leads into so many byways in the broad field of infection, that perhaps it can best be approached in a practical, clinical manner by asking a series of questions and attempting to answer them in the way in which any one of us might do, when the patient with the sore finger and red streaks running up his arm walks into our office.

The questions would be about as follows:

1. What is the cause of lymphangio-adenitis?
2. In what types of wounds, occupations or systemic states is the more serious type of infection apt to occur?
3. What are the usual symptoms?
4. What symptoms may differentiate the mild from the serious case?
5. Are laboratory findings an aid to prognosis or treatment?
6. What lymph nodes are involved in infections of the different body areas?
7. With what other condition may lymphangio-adenitis be confused?
8. What sequels may be sought or anticipated?
9. What surgical principles are involved in the immediate treatment? Why? How are they clinically applied?
10. What is the treatment of the sequels?

The descriptions and clinical aspects are taken from 32 cases reported by Koch<sup>1</sup> and 16 personal unreported cases. The mortality in these 48 cases was 25 per cent.

1. *Cause of Lymphangio-adenitis.* It results from inoculation of a primary skin wound with some type of streptococcus (94 per cent) or staphylococcus (6 per cent). Other pyogenic organisms may enter into the picture; but the term "streptococcic septicemia" is not a misnomer. Hand infections usually result from a puncture wound by pin, needle, or wire, or an incised wound from a knife or other sharp metal edge. Foot infections occur from an infected blister, callus, or toe nail and head and face infections from a traumatized furuncle.

In 31 cases in which laboratory findings were available the following microorganisms were found: hemolytic streptococcus 20; non-hemolytic streptococcus 8; streptococcus viridius 1; hemolytic staphylococcus 1; staphylococcus aureus 1. The cultures were taken from secondary abscesses or from blisters or pus at the site of the primary wound. There were but three positive blood cultures in the 48 cases.

2. *In What Types of Wounds, Occupations, or Systemic States Are the More Serious Types of Infections Apt to Occur?* In the trivial, non-bleeding, punctured hand wounds of those whose occupations predispose to skin soiling with infected material. Expect trouble in the acute lymphangitis following the needle prick of the surgeon's finger, which occurs when he is working on a necrotic appendix, sloughing cancer or pelvic abscess; in the nurse who is scratched with the pin concealed in her patient's garments or bandages; in the pathologist whose skin is entered by a sliver of broken glass from a test tube or who nicks himself while doing an autopsy; in the butcher whose knife slips while cutting up the more or less dubious meat scraps for the day's supply of hamburgers; and of the facial pimple which flares up in a few hours following my lady's efforts to quickly rid

herself of it by puncture and a hard squeeze. Hand infections are far and away the most frequent causes of serious acute lymphangio-adenitis and give the highest mortality; face infections come next; while foot, leg and peripelvic infections usually subside with nothing more serious than a localized gland abscess. It is worthy of note that in the 12 deaths in the 48 cases, 6 were in physicians and nurses. Spreading lymphangitis in the diabetic is always more extensive than in those with a normal blood sugar. But, strangely enough, it seems proportionately less fatal once the hyperglycemia is recognized and insulin is pushed, an argument in favor of those who advocate insulin in all extensive purulent conditions.

3. *What Are the Usual Symptoms?* When a skin lesion shows red wavy lines (tubular lymphangitis) running to the nearest lymph node, it means acute lymphangio-adenitis. It is the clinical stop signal to put the affected part and the patient at rest. A stinging, burning pain of the intermittant red hot needle type develops along the course of the lymph vessels and in the enlarged glands. As the process extends red lines appear from the glands first involved to the second set of tributary lymph nodes. In from six to twenty-four hours a spreading cellulitis (reticular lymphangitis) appears along the course of the lymph vessels and may spread to involve the whole member. The initial edema does not pit on finger pressure, as in thrombophlebitis. If the process is not arrested, localized abscesses may develop in the lymphnodes, or in the area of cellulitis, or the whole involved cellular tissue may undergo liquefaction necrosis. Fever and increased pulse rate accompany the local condition. A chill means that the lymph gland barriers have broken down, and that the invading organisms have entered the general circulation through the thoracic duct and subclavian vein.

Koch's<sup>1</sup> classification of end results, with the per cent in each class of the 48 cases, is as follows:

<sup>1</sup> KOCH, S. L. Acute rapidly spreading infections of the hand. *Surg. Gynec. Obst.*, 59: 277 (Sept.) 1934.

a. Those in which the infection gradually subsides without destruction of tissue or abscess formation, 12+ per cent.

b. Those in which the infection subsides but late breaking down of lymph glands occur, 17+ per cent.

c. Those in which the cellulitis is rapid and diffuse, with final liquefaction necrosis and the formation of localized abscesses in the cellular tissue, or with extensive diffuse destruction of tissue, 44+ per cent.

d. Those in which the infection advances rapidly in spite of all efforts to check it and goes on to a fatal septicemia, 25 per cent.

4. *What Symptoms May Differentiate the Mild from the Serious Case?* The serious case is marked by an acute onset with rapid spread of local signs and early appearance of constitutional symptoms. The red skin lines appear in two to six hours following the primary wound. Secondary lymph lines streak up the member with dramatic rapidity. Lymphedema is coincident with the local lymphangitis. Systemic symptoms of chill, high fever, nervous stimulation and delirium occur in the first thirty-six hours. The case in which the initial lesion was probed, squeezed, incised or scraped is more apt to go on to a fatal bacteremia than the conservatively treated case.

5. *Are Laboratory Findings an Aid to Prognosis or Treatment?* No. The average leucocyte count in the non-fatal cases was 17,800, and in the fatal cases, 20,000, which does not hold with the accepted theory that a low leucocyte count means poor resistance. There was an average jump of 2500 when pus localization occurred in the non-fatal cases. But presence of the superficial abscess was always clinically obvious. The proportion of non-hemolytic streptococcus, hemolytic streptococcus and Staphylococcus aureus was about the same in the fatal as in the non-fatal cases. There were but three positive blood cultures, all hemolytic streptococcus, in the 48 cases. It would seem that the possibility of checking a fatal infection lies in the individual's general resistance, more than in the leucocyte activity or in the strain of the invading

organism. Fatal cases were proportionately more numerous in those with indoor occupations.

6. *What Lymphnodes Are Involved in Infections of Different Body Areas?* These are graphically shown in Figures 2 and 3. Note that pediculi in children usually cause enlargement of the postoccipital and postauricular glands; that facial and upper lip lymphangitis is apt to be associated with thrombophlebitis; that infection of the ulnar side of the hand involves first the epitrochlear glands, but that the radial side gives primary axillary gland involvement; that infections on the palmar surface of the hand may extend through to the dorsal surface, but that dorsal infections do not spread to the palm; that dorsal infections of the fingers usually localize over the base of the metacarpals with the exception of the dorsal surface of the middle finger, where the lymphangitis runs directly to the clavicular glands; that foot and leg infections involve primarily the saphenous glands and that anal infections, a point often overlooked, involve the inguinal glands.

7. *With What Other Condition May Lymphangio-adenitis Be Confused?* With acute thrombophlebitis. The latter condition most frequently develops in the leg, next in the face and rarely in the arm. The differential diagnosis is graphically shown in Figure 4. Note that lymphangio-adenitis is always associated with an infected peripheral wound, while thrombophlebitis accompanies the infectious fevers, childbirth or operating wounds of the lower abdomen. In thrombophlebitis skin markings develop slowly, if at all; edema is immediate and pits on finger pressure and the lymph glands are not involved.

8. *What Sequels May Be Anticipated?* In the arm one must watch for a palmar abscess, local lymph gland abscess, or a diffuse phlegmonous abscess of the subcutaneous tissues. In the head and face one looks for spreading thrombophlebitis or submental or submaxillary lymph gland abscesses. In the leg one watches for a

saphenous or inguinal abscess and in any location, for systemic septicemia or pyemia.

*These Clinically Applied?* The principles of treatment are rest, stimulation of the local active hyperemia, elimination, combat

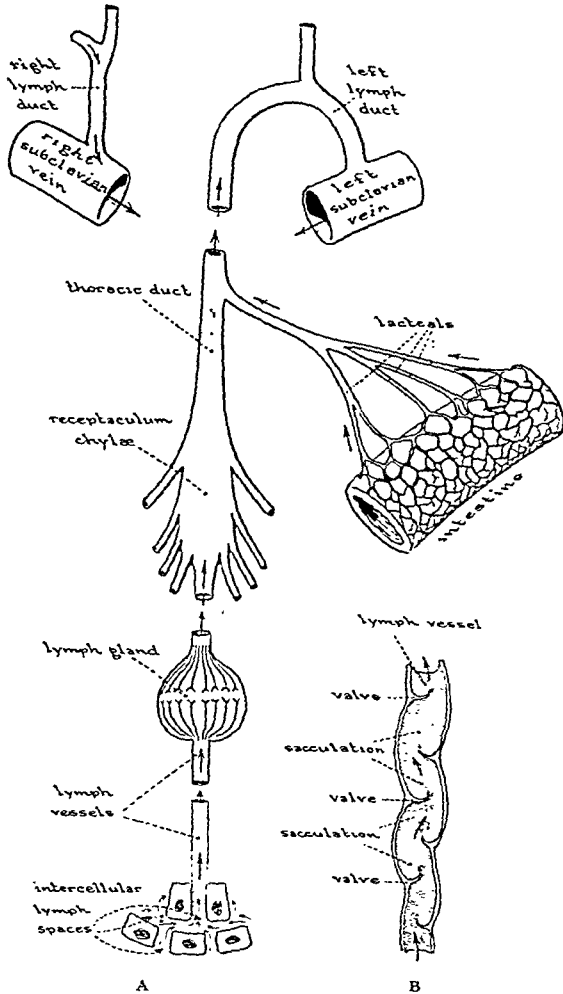


FIG. 1. Schematic chart of the lymphatic system. A. The lymph originates in the intracellular lymph spaces. From these spaces emerge the peripheral lymphatic vessels. The peripheral lymphatic vessels run into and break up in the lymph nodes. The lymph nodes filter, antitoxicate and sterilize the peripheral lymph. After leaving the lymph nodes all the deeper lymph vessels, except those of the right side of the face, neck, chest and right arm, empty into the receptaculum chylae and thoracic duct. The intestinal lacteals empty into the thoracic duct. The thoracic duct empties into the left subclavian vein through the left lymph duct. The right lymph duct empties into the right subclavian vein. There are two general lymphatic systems, the superficial and the deep, which have but slight communication through the deep fascia. B. The lymphatic vessels have many valves and tend to sacculate above each valve. These sacs give the beaded feel to superficial lymphangioma and to the palpable lymphatic vessels in chronic lymphangitis.

9. What Surgical Principles Are Involved in the Immediate Treatment? Why? How Are

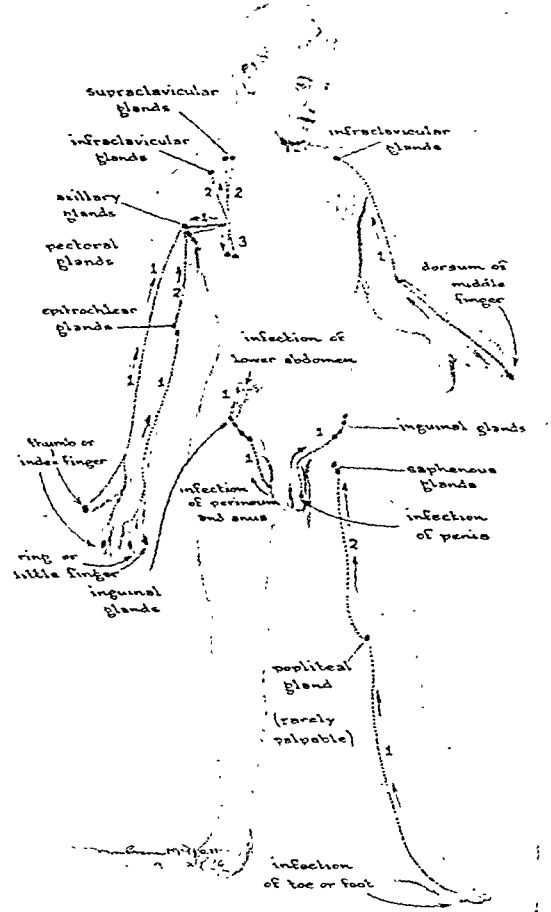


FIG. 2. Lymph drainage of the arm, breast and leg. Arm—Palmar surface: from the ulnar side of the hand and forearm; to the epitrochlear glands; to the axillary glands. From the radial side of the hand and forearm, directly to the axillary glands. Dorsal surface—to axillary glands, except middle finger which may run directly into the clavicular glands and subclavian vein. Breast—first to the axillary; then the clavicular; then the subpectoral glands. Leg—Feet and calf—to the popliteal glands, which are rarely palpable; to the vertical set of glands lying over the saphenous opening. Genitalia, arms, perineum, lower abdominal wall—to the oblique inguinal chain of glands along Poupart's ligament.

the systemic toxic acidosis; i.e., to assist the natural processes which the body calls forth to combat infection.

*Why Immobilization?* Because of the clinical results obtained in the cases so treated. It was formerly taught that the movement of the lymph was a very slow

process and that it was largely due to muscular action. Hudack and McMaster<sup>2</sup> upset this hypothesis when they showed

theless there is abundant clinical evidence to show that infection spreads more rapidly in the active than in the passive member;

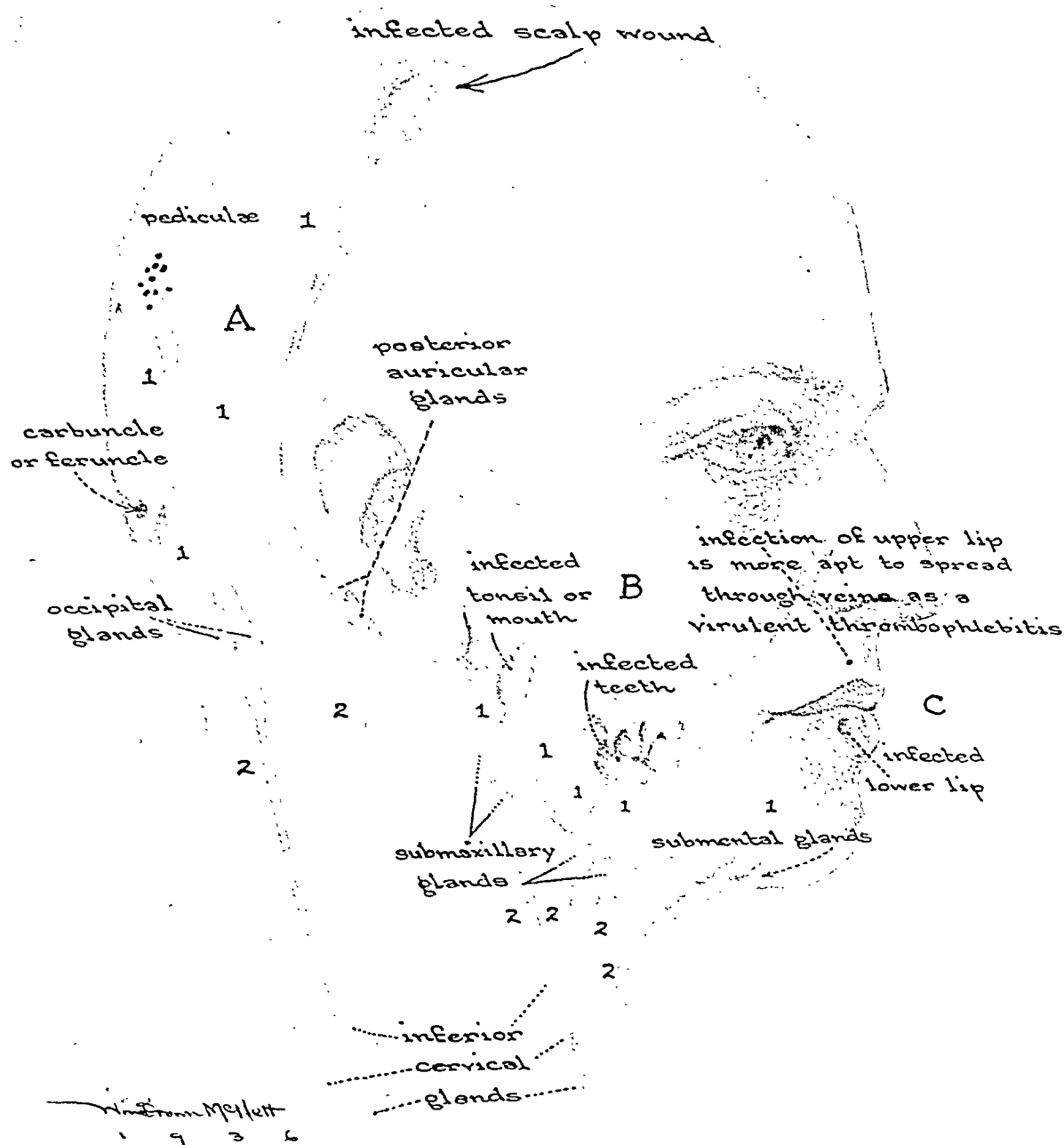


FIG. 3. Lymph drainage of the head, mouth and lips. A. Scalp (wounds, pediculi, furnucle or carbuncle) to occipital or postauricular glands; to glands of posterior triangle of neck. B. Mouth (ulcer, teeth, tonsils) to submaxillary glands; to glands of anterior triangle of neck. C. Lips. Lower (infection, herpes, cancer, chancre)—to submaxillary glands; to glands of anterior triangle of neck. Upper (carbuncle)—rarely to anterior auricular glands. Infection is more apt to spread through the veins as a virulent thrombophlebitis.

that dye diluted with toxins, injected intradermally in the hand reached the drainage trunks in the axilla in eight minutes. Never-

and that movement must interfere with the barrier wall of protective elements which Nature throws around the infected site.

<sup>2</sup> HUDACK, S. S. and MCMASTER, P. D. The lymphatic participation in human cutaneous phenomena. *Jour. Exper. Med.*, 57: 751-777, 1933.

*Why Encourage the Local Inflammatory Swelling by Hot Wet Compresses? The*

local swelling and redness is caused by inflammatory exudate. This exudate is composed largely of leucocytes, red blood

In face cases place sand bags to the sides of the head and avoid talking or swallowing. Cover the parts by massive, warm, wet, sterile saline dressings and keep them wet and warm, with no manipulative irritation of the primary lesion. The wet dressings keep it open and insure drainage. The exception is where the focus is covered by new epithelial growth or is an infected blister. Here gently cut through the overlying epithelium but do not draw blood. Force fluids by mouth, proctoclysis or hypodermoclysis. The latter method is sure and efficient. Neutralize acidosis by glucose intravenously and sodium citrate by mouth.

10. *What Is the Treatment of the Sequels-Palmar Abscess, Localized Glandular Abscess, Diffuse Purulent Cellulitis, Septicemia?*

**Palmar Abscess.** Clean cut incisions in the palm and above the wrist; wet dressings; no drains; Bier's passive hyperemia by an elastic bandage to the upper arm, two hours on and two hours off; soak the hand in hot saline fifteen minutes between the rubber bandage applications; squeeze the pus out gently through the incisions twice daily.

**Localized Glandular Abscess.** Wait for superficial fluctuation then open by a simple incision without retraction, curettage or digital exploration. A purulent lymphadenitis means that the infection has broken down the main line of defense; i.e., the lymph glands. The wall of leucocytes and fibroblasts surrounding the now functionless glands, is Nature's limiting wall against further entry of infectious matter into the systemic circulation and should not be broken down.

**Diffuse Purulent Cellulitis.** Simple incisions are to be made over each fluctuating area as it presents itself.

**Septicemia.** From the mortality standpoint septicemia falls into three classes; those cases which make a natural recovery irrespective of treatment; those which die in spite of every effort to save them; and the borderline case which immediate, vigorous therapeutic measures may pull

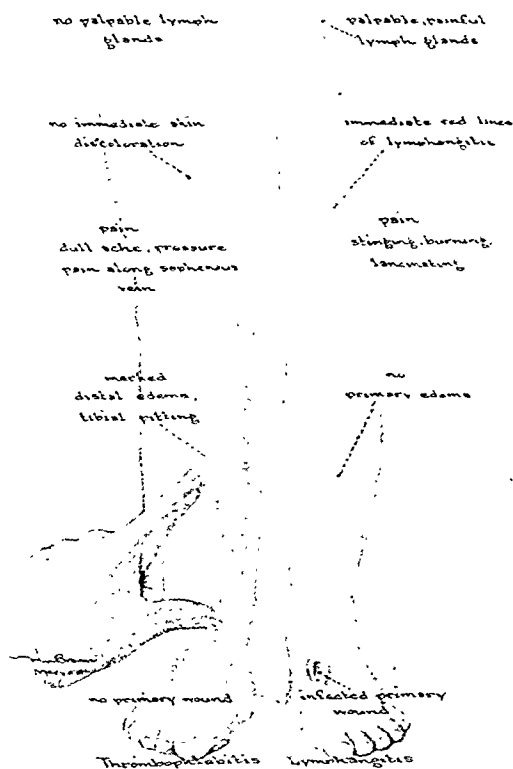


FIG. 4. Differential diagnosis between lymphangioadenitis and thrombophlebitis of the leg.

cells and plasma; i.e., the protective blood elements which are attempting to wall off and destroy the invading organisms and neutralize their toxins. Wet heat attracts blood and relaxes the tissues; thereby increasing the local concentration of the protective blood elements.

**Why Force Fluids?** To carry off by elimination through the kidneys, the bowels and the skin, the toxins circulating in the blood stream.

**Why Combat Acidosis by Alkalies and Glucose?** Because blood toxins are acids and their neutralization renders them less lethal.

The clinical plan of treatment may be summarized as follows:

Put the patient in bed and immobilize the arm or leg under an electric light cradle at a temperature of 105 to 110 degrees F.

through. Blood, glucose and saline are today the only known agents which may convert a near septicemic fatality into a convalescent. Repeated blood transfusion is the main therapeutic factor; glucose and saline are accessories. Anti-streptococcic sera have proved disappointing. In this fulminating condition, where days or even hours count, delay while this or that vaunted form of serum therapy is used may mean death or recovery. Analysis of 1000 recent blood transfusions at Temple University Hospital<sup>3</sup> showed that in over 60 per cent of the cases the indications for its use was some form of septicemia. The septic states were of every known etiology and involved practically every part of the body. In favorable cases, irrespective of location, there was a check of the spreading diffuse cellulitis or general toxic symptoms and a tendency to local abscess formation. The dose used was 250 c.c. of whole blood given every second day. The average number of transfusions was eight. Intravenous glucose was given on the days between the transfusions. Continuous hypodermoclysis of Bartlett's solution, novocaine, grains 5 in one pint of saline, was given until the crisis was passed.

#### SUMMARY

1. The term acute lymphangio-adenitis is suggested to designate the conditions.

<sup>3</sup> Records of General Surgical Service, Temple University Hospital.

2. Serious infections follow trivial skin wounds in those whose occupations predispose to skin soiling with infected material, i.e., doctors, nurses, laboratory technicians, undertakers, or in the diabetic.

3. The red skin lines running from a skin wound to the nearest tender lymph node is the primary symptom.

4. The serious case shows, within two to six hours, rapid spread of local signs and a chill within the first thirty-six hours.

5. To date no serum therapy has been brought forward of avail in the fulminating case, nor does the blood picture or the germ type aid us in prognosis.

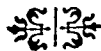
6. The lymphnodes involved are fairly consistent in infections of the different body areas.

7. A differential diagnosis between acute lymphangio-adenitis and acute thrombophlebitis is outlined.

8. Sequels to be expected in infections of different body areas are presented.

9. Primary local treatment is directed toward assisting those natural processes which the body calls forth to combat infection, i.e., rest; large, wet hot compresses; no local meddlesome surgery.

10. Plan of treatment of the sequels, i.e., palmar abscess, localized glandular abscess, diffuse purulent cellulitis, septicemia, is presented. Blood transfusion is the most reliable agent for septicemia, assisted by saline hypodermoclysis and intravenous glucose.





# HUMAN BITES

EDWARD P. DUNN, M.D.

Assistant Professor of Clinical Surgery, Long Island College of Medicine; Assistant Attending Surgeon, Long Island College Hospital; Associate Surgeon, Kings County and St. Mary's Hospitals

BROOKLYN, N. Y.

IT has been the experience of every surgeon to see the severe infections which frequently follow wounds produced by human bites, or other injuries produced by human teeth. These wounds, usually on the hands, produce infections which tend to spread diffusely as phlegmonous processes, discharge a foul pus, yield slowly to treatment, and end not infrequently with deformities or amputations.

It is possible to reduce the frequency and severity of these infections but to do so one must appreciate the factors responsible for the poor results. These are, the nature of the wound, the immediate introduction into it of organisms of a high degree of virulence under such conditions, and the anatomical relations of the areas most frequently involved.

The wounds are usually of the penetrating, puncture type with considerable destruction of surrounding tissue because of the nature of the force used. It is well known that wounds associated with tissue death are more likely to become infected than the clean incised type, and so it is not surprising that the less common type of tooth wound which produces an avulsion is less frequently followed by a serious complication.

Into these wounds are introduced a variety of organisms commonly found in the human mouth, such as *Staphylococcus aureus* and *albus*, *streptococcus* of various types, the fusiform bacillus and spirillum of Vincent's angina, and numerous spirochetes. In numerous instances syphilis has been transferred by the bite of an active luetic. The infection is rarely due to any single organism but is a true mixed infection. The Vincent's organisms and spirochetes when present are responsible for the

foul smelling, gangrenous nature of the wound, and when their presence may be shown by smear or culture the outlook is serious.

About 80 per cent of these injuries occur on the hands and fingers. The most common place is over the metacarpophalangeal joint of the middle or index finger, and it is caused by striking the clenched fist against the teeth of another. At this point virulent mouth organisms may be implanted directly into the subcutaneous tissues, tendons, subtendinous area or the joint. The anatomical arrangement here is such as to allow easy spread of infection in several directions. For an appreciation of these anatomical factors and the method of spread one is referred to the excellent work of Mason and Koch. The injection experiments of these investigators show the ease with which infection starting in the areas commonly involved in bites, spreads over and up the dorsum of the hand, distally along the fingers and anteriorly through the lumbrical to the palmar spaces.

The ordinary surgical treatment of these has proved unsatisfactory to most observers. Because of this fact Bates was led to treat all bites by electrocauterization. The patient was given gas anesthesia and with the electrocautery enough tissue was destroyed to remove the entire tooth mark. The treatment was used early preferably but in some cases as late as the third and fourth day. The decrease in the incidence of infection was very striking, in over 130 cases severe infection occurred twice only. In a recent report Lowry calls attention to the excellent results obtained by Bates and while admitting the excellence of the method, commented on the difficulties in persuading patients to permit gas anes-

thesia to be given and the unavailability of both the anesthesia and the electrocautery in many instances. As a simpler method of treatment he recommends the careful cauterization of the wound with fuming nitric acid, followed by a flushing with cold water. The method is painful for a short time only and is easily accomplished. In 122 cases treated by this method the result was satisfactory in 97 per cent of the 64 which were followed through. Another recent paper by Welch recommends the use of the electrocautery in deep wounds especially those involving the knuckle joint, and fuming nitric acid in the minor wounds.

The author's practice has been to use fuming nitric acid for cauterizing all bites, both human and animal. In those cases in which infection is already present when first seen, adequate incisions should be made. Most complications follow inadequate drainage so it is important to plan the incisions with due regard for the anatomy as revealed in the work of Mason and Koch.

#### SUMMARY

Human bites produce infections of an extremely virulent nature because of the

type of wound, the organisms introduced, and the anatomical arrangement of the parts involved.

These infections not only cause a great loss of time to the individual, but often cause loss of function in parts of the hand, amputations of digits and extremities, and occasionally death.

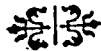
The treatment outlined will reduce considerably the incidence of infection and reduce its severity when it does occur:

1. Cauterization of all wounds thoroughly with fuming nitric acid or an electrocautery. No attempt should be made to close the wound.

2. All infected wounds must be carefully but radically incised without delay, unless marked lymphangitis is present. Following incision warm moist dressings should be used followed by irrigation with potassium permanganate 1:1000, hydrogen peroxide or other oxidizing solution.

#### REFERENCES

- BATES, W. Electrocauterization in the treatment of human bites. *Ann. Surg.*, 93: 614, 1931.  
LOWRY, T. M. The surgical treatment of human bites. *Ann. Surg.*, 104: 1103, 1936.  
MASON, M. L. and KOCH, S. L. Human bite infections of the hand. *Surg. Gynec. and Obst.*, 51: 591, 1930.  
WELCH, C. E. Human bite infections of the hand. *New England Jour. Med.*, 215: 901, 1936.



# NEW METHOD FOR TRANSFER OF FULL-THICKNESS SKIN: GRILLE GRAFT\*

G. FRANK SAMMIS, M.D., F.A.C.S.

Senior Surgeon, St. John's Hospital, Brooklyn; Plastic Surgeon, Queens General Hospital, Jamaica

HOLLIS, NEW YORK

THE plastic surgeon is often confronted with conditions demanding the use of full thickness skin for reconstructive



FIG. 1. Condition before Grille graft was applied.

and corrective purposes. Free grafts are not always successful and they leave unsightly scars on donor sites. The tubed pedicle of Gillies is almost uniformly successful but requires two or more operations, long hospitalization, uncomfortable immobilization and return to society is long deterred. It has been the practice of the writer, when the tube shall have served its purpose, to discard the proximal unused segment instead of replacing it in its original bed. In this way, a single longitudinal scar results, where replacement necessitates two and this also avoids an additional operative procedure. Results of pinch grafts are not pleasing cosmetically, on either donor or recipient sites.

Douglas has devised the "sieve graft," which has been very satisfactory in the

writer's experience but the donor site is large and slow to heal and the dissection, leaving the islands of intact skin on the donor site, is tedious, slow and difficult. No undermining of adjacent skin is practical, as it would result in covering the islands and defeat the object for which they were intended. Of course, it might be practical to leave a larger area of intact skin at the free edges of the graft, thereby making fewer islands and then undercut the donor site edges and partially close the wound. It would still be tedious and take much time to dissect around these several islands.

So, in an effort to overcome these difficulties and objections, the author presents an original method and has called it the Grille graft.

It consists of leaving one, two or more narrow parallel strips of skin on the donor site undisturbed to act as islands, establishing centers from which healing begins to take place very early postoperatively.

Very little, if any, allowance need be made for "shrinkage" of the graft during its application to the recipient site, in contrast to the "sieve graft" where it is recommended that the graft be about 25 per cent oversized. This, of course, means the area from which the skin is taken, is larger and slower in healing.

Surrounding edges of the donor site may be undermined to varying degrees, drawn toward the islands and sutured to them, thereby effacing a large area of the defect left by the removal of the graft.

The recipient site is prepared in the usual way, removing exuberant granulations when necessary, applying hot pads and pressure to obtain as nearly complete hemostasis as possible. A pattern or

\* Read before the Brooklyn Surgical Society, December, 1936.

template may be made, after the recipient site shall have been prepared and applied to the donor site as an outline, then transfer

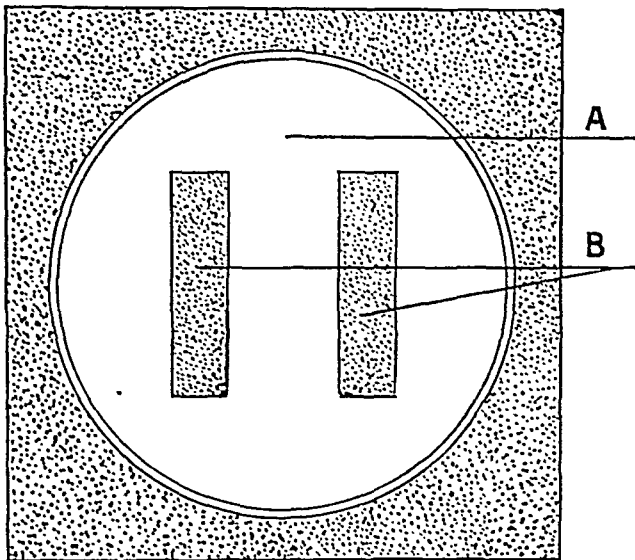


FIG. 2. Diagram showing strips of skin left intact on donor site; A, graft; B, skin left intact on donor site.

the full thickness skin and suture it carefully in place, accurately apposing the edges. This leaves one, two or more

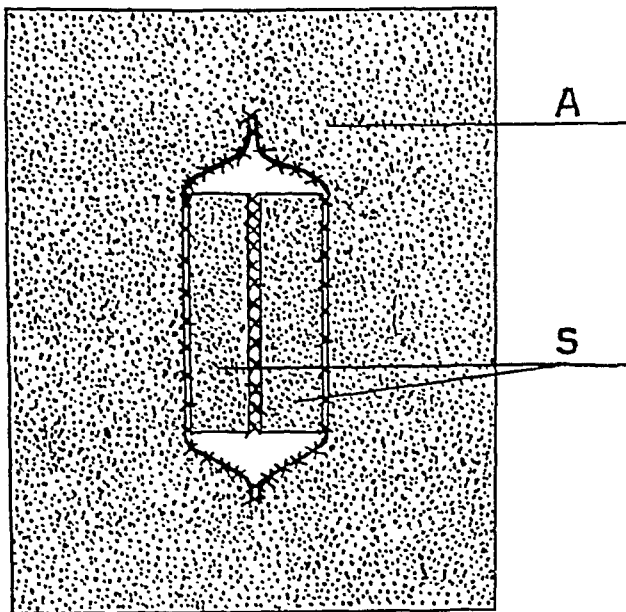


FIG. 4. Diagram showing undermined skin edges sutured to islands of skin on donor site; A, adjacent skin undermined, slid and sutured to itself and to intact skin; S, skin left intact on donor site.

“ventilated” areas, according to the size of the graft, to allow the escape of serum and air bubbles, when sea-sponge shall have been applied.

Following is a typical case report

A. S. age six years, colored male, was admitted to St. John's Hospital, Brooklyn, with extensive burns of the arms, abdomen and

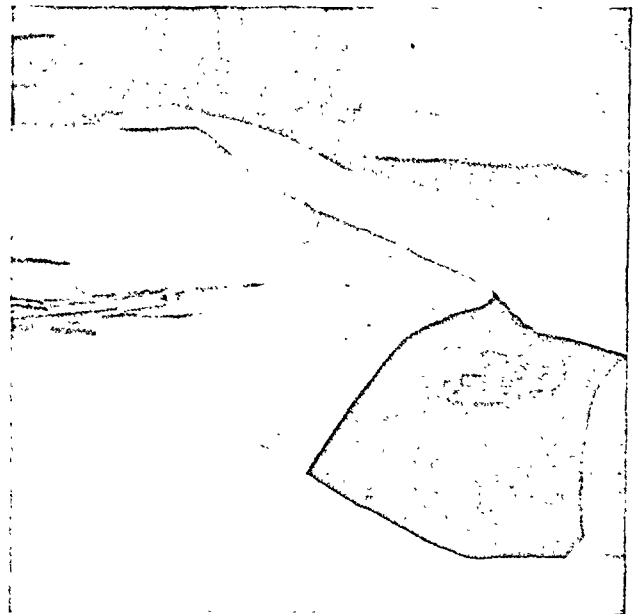


FIG. 3. Donor site after removal of graft following technique shown in Figure 2.

chest. The surfaces were tanned early and fairly good results were obtained except for two



FIG. 5. Undermined skin edges sutured to islands on donor site, as shown in Figure 4.

areas on the extensor surfaces of the left elbow, about 3 by 5 cm., which resisted treatment and skin grafting was elected.

On May 29, 1936, Grille grafts were raised from the anterior surfaces of both thighs and transferred to the left elbow. Usual sea-sponge

dressing was applied to the recipient site and vaseline gauze to the donor sites.

Healing progressed, the grafts having "taken" to such an extent that an older pa-

1. The ease with which the graft is raised; ten minutes is the usual time necessary to dissect a moderate sized graft with two openings;

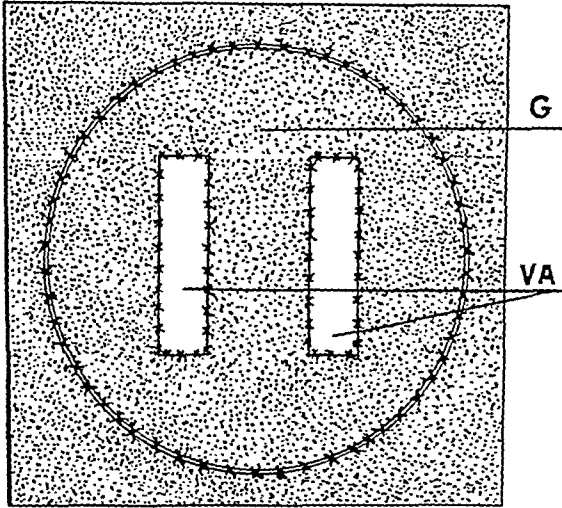


FIG. 6. "Ventilated" areas of skin having been left on donor site; G, grilled graft sutured into recipient site; showing VA, "ventilated areas."



FIG. 7. Two Grille grafts sutured in place, as shown in diagram in Figure 6.

tient might have left the hospital at the end of the fourteenth day. The wounds were

2. Partial closure of the donor site;
3. "Ventilation" of the recipient site;



FIG. 8. Recipient site healed, twenty-two days.

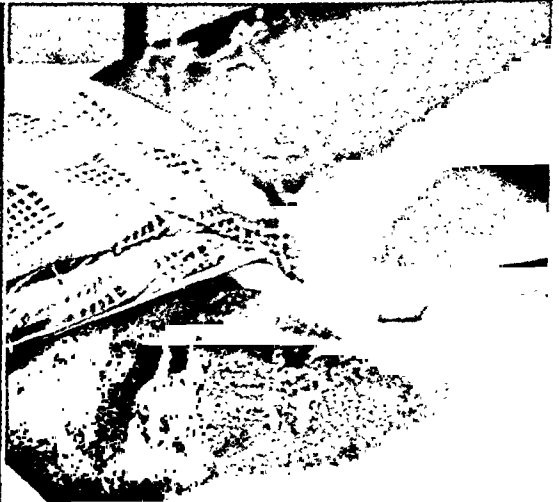


FIG. 9. Donor site healed, fourteen days.

firmly healed and all dressings removed at the end of twenty-one days.

#### CONCLUSIONS

The advantages claimed for this method are as follows:

4. Rapid healing and presentable scars at both sites;
5. Less restriction of the parts by immobilization, and shorter hospitalization; together with the advantages of the sieve, the tube and other full thickness skin

transfers, namely, prevention of subsequent contractures, as in flexor surfaces such as the popliteal and axillary spaces;

where skin and superficial fascia are not plentiful;

7. The restoration of denuded areas on

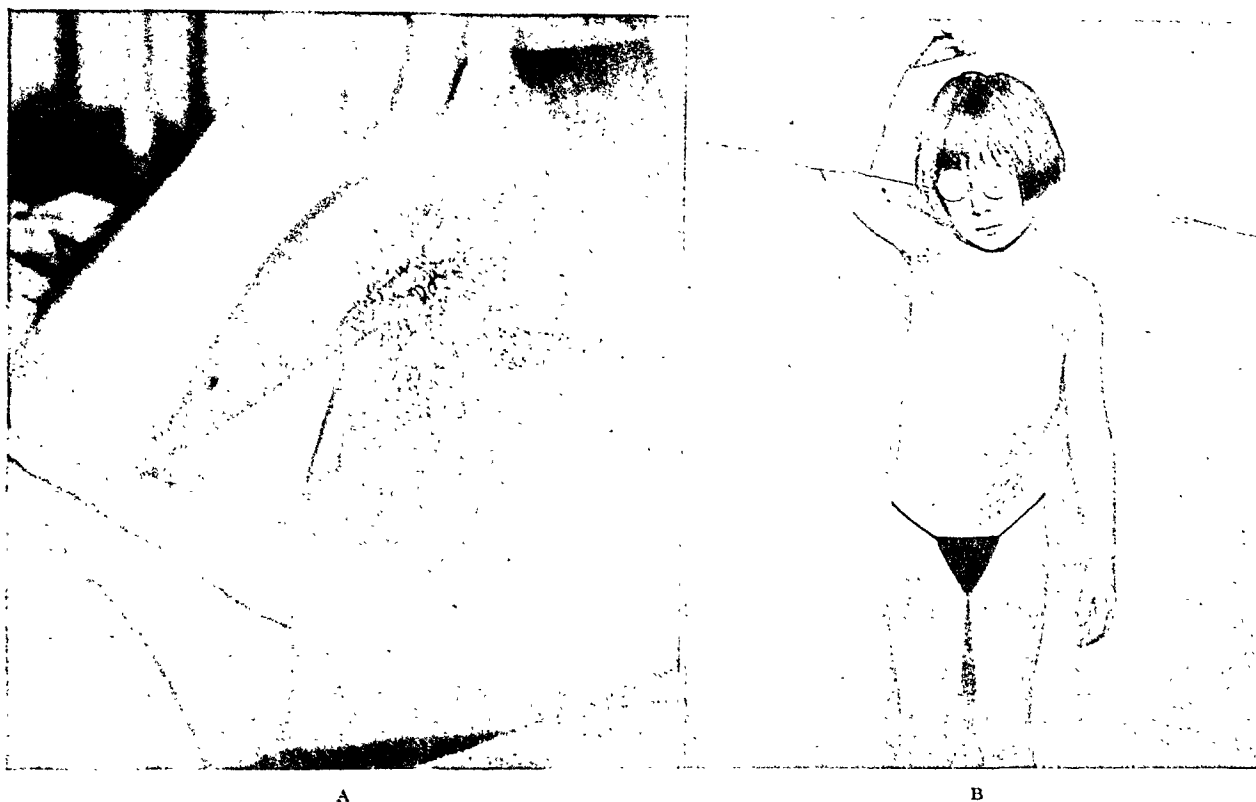


FIG. 10. A, Complete excision of all the scar tissue could not be accomplished because of its density and its extent from the forearm to the chest, hence the grafts were sutured to the surrounding areas of abnormal skin; B, end-result four months postoperatively, showing almost complete extension and healed areas of donor site.

6. Prevention of desquamation and "cracking" on extensor surfaces, such as the elbow, knee and other locations

scalp or skin, following the deep removal of malignant growths; and

8. In indolent varicose ulcers.



# BURNS\*

A DISCUSSION ON THEIR TREATMENT, BOTH IMMEDIATE AND REMOTE,  
WITH SPECIAL EMPHASIS ON THE PREVENTION OF SCARS AND CONTRACTURES

WALTER A. COAKLEY, M.D., F.A.C.S.

Chief, Division of Plastic and Reconstructive Surgery, Kings County Hospital; Plastic Surgeon, Brooklyn Eye and Ear, and St. Mary's Hospitals

BROOKLYN, NEW YORK

THIS paper is based on a series of 300 consecutive cases of sufficient severity to warrant hospitalization. The entire treatment, both medical and surgical, is supervised by a small group of men who are on service throughout the year so that there is a continuity of treatment and method which works for the advantage of the patient. Many of our scar cases are hospitalized for several months at a time and we are thus able to carry out lengthy and time-consuming medical and surgical procedures without the usual interruptions which take place with a change of services. These cases have been personally supervised by the writer within the past three years.

## CLASSIFICATION OF BURNS

The time honored classification of burns has been that of the first, second and third degrees, depending on the depth of the burn, from the superficial erythema to bleb formation and finally to destruction of the skin and the underlying structures; this however presents a very inadequate survey of a case. The location and extent of the burn is also of the utmost importance. In addition the following questions must be considered: Is the burn old or recent? Is it clean or infected? And if infected, what is the predominating organism? What is the age of the patient? Are there any complicating factors such as senility, diabetes, alcoholism, epilepsy, heart or pre-existing kidney involvement? What caused the burn? Chemicals, flame, electricity, hot liquids, x-ray or radium, the sun? Are any special areas such as flexor surfaces, the

eyes, mouth, throat, perineum involved? What is the condition of the patient on entering the hospital? Is he in shock, pain, dehydrated, toxic, emaciated? Does his urine show secondary kidney changes? Any previous treatment? How much normal skin is left? What is the probable prognosis?

A survey such as this, on the first examination of a patient with any burn is important in outlining a course of treatment. To help in the standardization of our methods in so far as possible, the following chart was devised and is used in every case as an integral part of the record. Prior to this all our cases were photographed in an attempt to show the types and extent of the areas involved. This chart is more satisfactory for all these questions are answered, and the burned area can be accurately mapped out.

## TREATMENT, IMMEDIATE

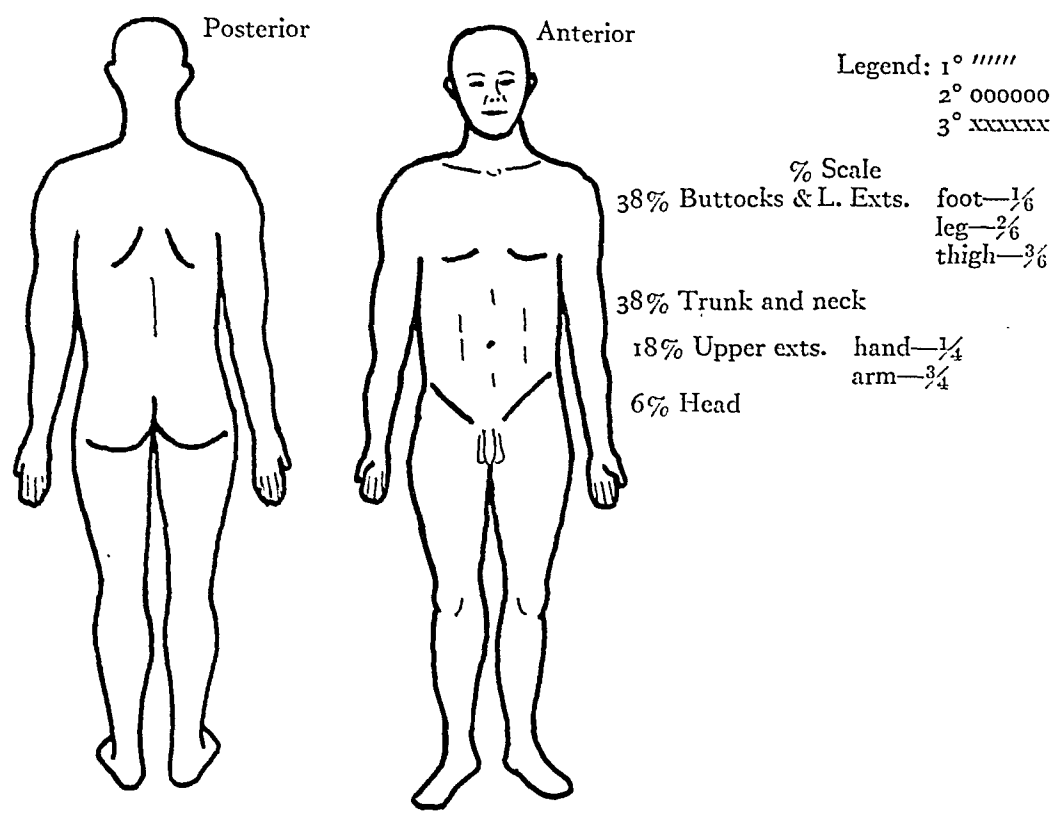
No attempt is made to discuss the merits of the various methods advocated for the treatment of burns, and the role of infection is so important that it will be taken up at some future time. Suffice it to say that the multitude of methods and medications, all effective in the hands of the individual worker, is indicative that no one treatment should be the "accepted one."

The following is the routine treatment in use on our service: On admission, measures are taken to relieve pain by the generous use of morphine or codeine or tincture opii in children. Shock is combatted by the administration of fluids by all available routes, the use of external heat and

\* From the Department of Plastic and Reconstructive Surgery, Kings County Hospital.

stimulants. All clothing and debris are removed. Tetanus antitoxin is given. A complete debridement is done on the wards, 10 per cent, gentian violet 1 per cent, tannic acid 5 per cent and gentian violet 1 per cent combined, a tannic acid jelly, picric acid

Name.....Age.....Color.....



Type: a. Recent.....Old.....Previous Treatment.....  
b. Clean.....Infected.....Pot. Infected.....

Percentage: 1°.....2°.....3°.....

|                                 |                  |
|---------------------------------|------------------|
| Joint & Special Areas Involved: | End Result:      |
| Elbow.....                      | Died.....        |
| Fingers.....                    | Healed.....      |
| Axilla.....                     | Scarred.....     |
| Neck.....                       | Contracture..... |
| Knee.....                       | Cosmetic.....    |
| Other.....                      | Functional.....  |
|                                 | Other.....       |

Cause: .....

Prognosis: .....

Complications: .....

Operations: Yes.....  
No.....

FIG. 1. Burn chart, Division of Plastic Surgery.

anesthesia rarely being needed; the skin is cleaned; all ointments are removed and if acid or alkali burns are present, the offending substance is washed off with copious quantities of normal saline and then the appropriate antidote applied.

The question arises as to what to apply to the burned area. We have used the following, tannic acid from 5 per cent to ointment, silver nitrate solution 10 per cent, and irratdiaed petroleum, and a cod-liver oil ointment. Each is useful, none can be universally used. Our preference is for the freshly prepared tannic acid and gentian violet mixture. This is sprayed on the burned areas every fifteen minutes and dried with a hot air blower similar to that used in the hair-dressing establishments.



This is done for a period of two hours, then at longer intervals for the next twenty-four hours. A firm, soft coagulum is formed,

often misleading due to concentration. A distinctly anemic patient from the standpoint of clinical observation may present a



FIG. 2. Hypertrophied contracted scar of anterior neck.



FIG. 3. Extensive unstable scar of back accompanied by contracted scar of axilla.

pain is relieved, fluid loss is decreased, body heat is preserved and infection is minimized. The patient is at all times upon a sterile sheet, and is under an electric light cradle, where a constant temperature of 99 degrees F. is maintained.

The continuous intravenous administration of fluids is useful in the early treatment of extensive burns and later, a high vitamin and high caloric diet is prescribed. Patients with burns of the chest and abdomen are turned from side to side frequently, as allowing them to remain on their backs for weeks at a time predisposes to a hypostatic pneumonia, especially in elderly people.

An extensive burn usually means a long period of hospitalization and the case should be treated as one would treat a chronic bedridden patient. Bed sores, etc., should be prevented.

Anemia is a frequent complication in the extensively burned and the blood count is

blood count which belies his physical appearance.

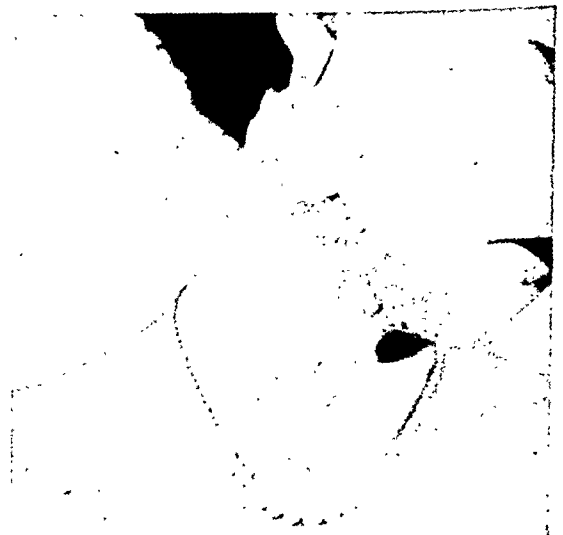


FIG. 4. Hypertrophied contracted scar of face and neck.

In such cases we favor the use of small indirect blood transfusions of 75 to 100 c.c.,

used early and frequently until there is a distinct improvement in the color of the skin and mucous membranes. The transfusions are usually supplemented by quartz light in tonic doses.

Early skin graft is used if the flexor surfaces about the joints are involved. These areas should never be allowed to heal by slow epithelization if there is any question of limitation of motion or loss of function. If so allowed, extensive deforming, contracting scars are the result; either the unstable parchment-like type or the hypertrophied contracted variety.

The time loss in these cases as compared to those grafted is considerable and the great responsibility of the surgeon, to the patient who has survived extensive burns, is the preventing of these deforming and incapacitating scars.

It is important that skin grafting be performed before deep scarring takes place especially in such regions as the elbow, the popliteal space, the axilla, the anterior neck region and the fingers. Apparently insignificant burns, especially of the hands, may be followed months later by contracted and distorted fingers. The well equipped ward should have several fracture beds on which vertical, horizontal and longitudinal tractions, with pulleys, can be erected.

The ingenuity of the surgeon is often taxed to the limit, especially where children are concerned, for they are notorious for their ability to slip out of all sorts of casts and extension devices.

Many weeks of this traction may be needed and it must be supplemented by massage and passive motion, etc., long after a cure is apparently obtained.

The incidence of contractures, which have developed on our service following such procedures has been small.

#### PROGNOSIS

The prognosis except in cases obviously not dangerous must be guarded. Death from shock within the first forty-eight hours, occasionally occurs, especially in elderly patients. Children apparently well on the road to recovery, may suddenly go into convulsions and die. Diabetes, nephritis, etc., are very dangerous accompanying diseases.

The prognosis as to the limitation of motion, loss of function, etc., is the important one. The surgeon should see to it that the important regions mentioned should be guarded with the utmost care, in order that the afflicted patient may be returned to his world as nearly normal as possible.

The accompanying photographs illustrate some of the contractures resulting from long periods of epithelization.

#### SUMMARY

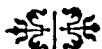
Not enough stress has been laid upon the prevention of contractures following burns.

The location of the burn is often more important than the degree.

Early skin graft should be performed in all extensive burns.

The primary survey in which the location of the burn and the amount of normal skin remaining are determined and are all important.

To prevent contractures not only must mechanical appliances be used, but a long follow-up period of massage, active and passive motion, etc., is necessary. This must be continued long after the burn has healed.



# TREATMENT OF BURNS WITH BRILLIANT GREEN

JOSEPH K. NARAT, M.D.

Attending Surgeon, St. Elizabeth's Hospital

CHICAGO, ILL.

THE treatment of burns underwent great changes in the last decade and is now dominated by the use of tannic acid, either the original Davidson method<sup>1</sup> or one of the numerous modifications. Taylor<sup>2</sup> recently called attention to the misuse of tannic acid in milder, "second degree" burns, as many of the epithelial cells that might take part in the repair of the denuded area, are "tanned" by the treatment and repair is thus delayed.

It is not the intention of the writer to detract from the value of the tannic acid treatment but the method has its limitations. Aldrich<sup>3</sup> suggested the use of a 1 per cent solution of gentian violet which destroys germinal epithelium to a lesser extent than tannic acid and does not cause the severe local reaction encountered after "tanning." De Hart<sup>4</sup> reported favorable results obtained with this method. Another anilin dye, brilliant green, has been found still more efficacious.

Krumwiede and Pratt<sup>5</sup> studied the bacteriostatic effect of this dye and found that the inhibition of growth has been most evident among the Gram-positive bacteria. Ligat<sup>6</sup> reported very satisfactory results with this dye. Browning et al.<sup>7</sup> recommended the use of brilliant green for treatment of infections caused by the cocci group; they found the bactericidal power of the dye to be considerably lower toward *Bacteria coli*. Kligler<sup>8</sup> in an extensive study at the Rockefeller Institution found brilliant green an effective antiseptic in the following dilutions:

|                        |       |           |
|------------------------|-------|-----------|
| <i>B. aerogenes</i> .. | 1-    | 100,000   |
| <i>B. coli</i> .       | 1-    | 675,000   |
| <i>B. typhosus</i>     | 1-    | 510,000   |
| <i>B. proteus</i>      | 1-    | 675,000   |
| <i>B. subtilis</i>     | 1-15, | 000,000   |
| <i>S. aureus</i>       | 1-    | 4,000,000 |

Norton and Davis<sup>9</sup> state that brilliant green is the most active dye they found, as far as bacteriostatic action on *Streptococcus viridans* and *pneumococcus* is concerned.

Baccal<sup>10</sup> revived the interest in brilliant green by recommending its use in minor surgery, in preoperative preparation of the skin, in sterilization of the hands, catgut and surgical instruments and treatment of burns and certain external eye diseases, such as blepharitis. In 1931 the writer<sup>11</sup> offered a clinical study of the value of brilliant green as a local antiseptic. In 1934 he also reported a large series of various pyogenic conditions favorably treated with brilliant green. Morrow<sup>12</sup> uses a mixture of 1 per cent gentian violet and 1 per cent brilliant green in a 50 per cent alcoholic solution for the tinea-like condition between the webs of the toes. Brind<sup>13</sup> highly recommends brilliant green for the treatment of pyoderma, furunculosis, deep trichophytosis, folliculitis, scabies, and eczema complicated by pyogenic infections. He uses aqueous or alcoholic solutions, powders or pastes containing brilliant green. Ryles<sup>14</sup> found that injections of "Bonney's Blue" which consists of brilliant green and crystal violet, are at least as effective in leprosy as chaulmoogra oil. Korytkin-Novikov<sup>15</sup> treated 48 burn cases with brilliant green; in 31 a second degree burn was present; a complete regeneration of skin was obtained. In 6 deep burns an elastic, movable scar resulted. The hospitalization time was markedly shortened. Kozdoba<sup>16</sup> infected artificially produced wounds in animals with *Bacterium coli*, *streptococcus*, *staphylococcus*, *Bacillus pyocyaneus* and *tetanus bacillus* and compared the effect of brilliant green, pyoctanin, rivanol, tincture of iodine, bichloride of mercury, hypertonic

solution of sodium chloride and sodium acetate. Rivanol, brilliant green and pyoc-tanin were found to be the most effective drugs. A pharmaceutical company informed the writer that it began using brilliant green in March, 1930, in the manufacture of smallpox vaccine. The product carries a much lower amount of organisms per centimeter than the maximum required by government regulations. Ingram<sup>17</sup> praises the use of a mixture of hydrogen perchloride and brilliant green in the treatment of sycosis. Nakashima<sup>18</sup> found injections of brilliant green into the peritoneal cavity to be harmless. Kline<sup>19</sup> studied the toxicity of brilliant green for certain bacteria; he presented a method by which it seems possible to determine the bacteriostatic titer in a given sample of brilliant green.

Brilliant green chemically is a diamino-triphenylmethane compound. The product is a green powder, soluble in water and alcohol. The aqueous solution is not stable and should be freshly prepared. Brilliant green offers the following advantages in the treatment of burns:

1. Great inhibitory power toward the common pathogenic microorganisms;
2. Rapidity of action;
3. No deleterious effect on phagocytosis and other defensive processes of the organism;
4. Absence of irritating effect; and
5. Stimulation of granulation tissue.

All these properties make brilliant green very desirable for the treatment of burns. The only disadvantage seems to be the staining property of the dye. The stains may be removed from cloth by the use of a solution containing 90 per cent alcohol and 10 per cent dilute hydrochloric acid. Stains can also be removed by immersing clothing in a solution prepared by dissolving about 200 gm. of sodium perborate in 50 liters of hot water. After immersion the solution should be brought to a boiling point and allowed to boil for approximately one-half hour. If any stains still remain, they can be easily removed by applying good

soap or soap powder directly to the stained spots, then thoroughly rinsing and drying the clothing. Another method is as follows: to every 4 oz. of hot soap solution add one tablespoon of hydrogen peroxide; immerse clothing and leave for some time in hot solution; rinse well in cold water and dry. The stains on the hands can be removed by vigorous rubbing with alcohol.

In treating burns with brilliant green, the surrounding skin is painted with a 1 per cent solution of brilliant green in 60 per cent alcohol. After the customary toilet of the wound, the burned area is painted with a freshly prepared 1 per cent aqueous solution of brilliant green. Alcoholic solution is not advisable for the first treatment because it produces a smarting sensation. After three to five days, when the initial pain has subsided, the alcoholic solution can be used. The burn is covered with a thin layer of gauze. The applications are made once or twice a day, according to the amount of secretion. After a few days the alcoholic solution is substituted by a brilliant green jelly, which consists of a 1 per cent pure brilliant green in a water soluble jelly base of gum tragacanth. This jelly is allowed to dry on the wound for five to ten minutes and is then covered with a thin layer of gauze coated with sterile vaseline. This precaution is necessary, as otherwise the gauze adheres to the jelly and the change of dressing might be painful. The gauze is changed every two to four days if there is any secretion. Generally, however, no change is required for several days because the jelly forms a soft, flexible crust which has a dehydrating effect.

It goes without saying that the customary procedures to combat an existing shock are carried out; the usual systemic treatment is employed. If the patient is hospitalized, the burn is not covered with dressing; a light bulb is placed in the cradle.

As compared with the tannic acid treatment, this method offers the following advantages:

1. No frequent spraying is required.

2. The wet, oozing areas become dry without any chance of accumulation of pus under the eschar.

3. Brilliant green does not destroy the germinal layer but, on the contrary, it stimulates granulations.

Large series of comparable cases with deep burns must be treated with tannic acid or brilliant green to establish their relative values. In the treatment of second degree burns brilliant green seems to be superior to tannic acid in view of the features mentioned.

#### SUMMARY

Brilliant green offers the following advantages in treatment of burns:

1. Inhibitory power toward the common pathogenic microorganism;
2. Rapidity of actions;
3. No harmful effect on phagocytosis and other defensive processes of the organism;
4. No irritating effect; and
5. Stimulation of granulation tissue.

As compared with the tannic acid treatment, this method offers the following advantages:

1. No frequent spraying required;
2. The wet, oozing areas become dry without any chance of accumulation of pus under the scab; and
3. Brilliant green does not destroy the germinal layer but, on the contrary, it stimulates granulations.

#### REFERENCES

1. DAVIDSON, E. C. *Surg., Gynec. and Obst.*, 11: 202, 1925.
2. TAYLOR, F. J. A. M. A., 106: 1145, 1936.
3. ALDRICH, R. H. *New England Jour. Med.*, 208: 299, 1933.
4. DE HART, R. M. *Virginia Med. Monthly*, 62: 594, 1936.
5. KRUMWIEDE, CH. and PRATT, J. S. *Jour. Exper. Med.*, 19: 501, 1914.
6. LIGAT, D. *Brit. Med. Jour.*, 1: 78, 1917.
7. BROWNING, C. H., KENNAWAY, E. L., GULBRANSEN, R. and THORNTON, L. H. D. *Brit. Med. Jour.*, 1: 73, 1917.
8. KLIGLER, I. J. *Jour. Exper. Med.*, 27: 463, 1918.
9. NORTON, J. F., and DAVIS, G. E. *Jour. Infect. Dis.*, 32: 220, 1923.
10. BACCAL, S. A. J. A. M. A., 95: 215, 1930; *Naukora Dumka* (Pamphlet in Ukrainian) 1930.
11. NARAT, J. K. *Ann. Surg.*, 44: 1007, 1931; *Zentralb. f. Chir.*, 61: 2871, 1934.
12. MORROW, H. *Arch. f. Dermat. u. Syph.*, 25: 957, 1932.
13. BRIND, A. I. *Sovetsk. Vrach. Gaz.*, 17-18: 809, 1933.
14. RYLES, C. S. *Leprosy Rev.*, 4: 113, 1933; abst. in *Zentralbl. f. Haut- u. Geschltsky.*, 47: 178, 1934.
15. KORYTKIN, L. E. and NOVIKOV. *Sovetsk. Vrach. Gaz.*, 1: 22, 1934.
16. KOZDOBA, A. Z. *Nov. Chir. Arch.*, 30: 181, 1934.
17. INGRAM, J. T. *Practitioner*, 135: 479, 1935.
18. NAKASHIMA, C. *Mitt. a. d. med. Akad. Kioto*, 4: 341, 1935.
19. KLINE, E. K. *Am. Jour. Publ. Health*, 25: 314, 1935.



# INFECTIONS OF HEAD

REYNOLD ERSKINE CHURCH, M.D., F.A.C.S.

Assistant Professor in Surgery, New York Post-Graduate Medical School of Columbia University; Assistant Visiting Surgeon, Bellevue Hospital

NEW YORK

THE frequency with which small injuries and infections of the head have progressed to a degree of severity that will cause either death, loss of an important structure or a disfiguring scar has caused surgeons for many years to search out the pathways of bacterial extension so that more efficient therapy could be undertaken. Unfortunately, very little of this information has been available in the literature and it is only in recent years that detailed anatomical studies have made possible clear explanations.

Any discussion of so grave and comprehensive a subject, which must be made within a limited time, will of necessity be limited in its scope to the more important factors involved and many of the less grave types of infection cannot be touched upon. In this paper, no attempt will be made to discuss infections involving the field of the otolaryngologist or ophthalmologist. Also, in spite of the fact that infection of the neck may be the result of extension from the head and vice versa, no discussion of these neck infections or anatomy will be undertaken except as it is necessary to clarify extension of infections in structures found in the face and cranium.

Historians have produced evidence that clinicians of ancient time were aware of the seriousness of this condition and translations of their writings are of great interest in the light of our modern knowledge. An ancient Egyptian Papyrus of about 1600 B.C. contained 48 case histories, mostly dealing with head injuries and infection. It clearly described the resultant complications so common to modern surgeons. Hippocrates published a treatise on "Wounds of the Head" about 400 B.C. In this manuscript he advised the use of wound irrigations by wine and clean water, the latter

preferably boiled. He also suggested the close approximation of wound edges and gave the first description of healing by first and second intention. He also described many of the complications of head injuries and infections.

It seems best for purposes of clarity to divide this topic under two main headings; (1) the anatomy of the parts; and (2) the source and types of infections with their treatment. This will allow a fairly complete discussion of the important fundamentals to be taken up early so that they can be referred to later.

## ANATOMY

Infections involving tissues of the head may spread to contiguous structures by one or more of three routes; (1) by the lymphatic system with its drainage of the involved parts; (2) by the vascular system in which both the arterial supply and the venous drainage are important and (3) by anatomical continuity. This anatomical discussion must necessarily be brief but a knowledge of it is of paramount importance for no understanding treatment can be undertaken without it.

The lymphatic vessels which drain the scalp and face are both numerous and complete and infections are always accompanied by glandular involvement. This is of great value as it often directs attention to the area in which the infection first starts before it is otherwise apparent.

The scalp is drained posteriorly by vessels that terminate either in lymph glands which lie superficial to the mastoid part of the temporal bone, or in occipital lymph glands which lie in the neighborhood of the superior nuchal line. Anteriorly these vessels end either in glands which are embedded in the superficial surface of the

parotid gland or in the superficial and deep cervical groups. The area above and about the ear is drained to the posterior auricular glands.

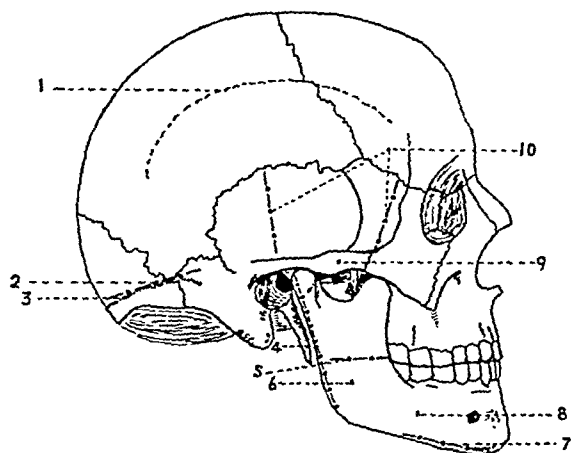


FIG. 1. View of skull showing important bony landmarks and site of incisions for closed spaces; 1, superior temporal line; 2, site to drain extravasations beneath galea and occipitalis muscle; 3, superior nuchal line; 4, site of incision to drain parotid space; 5, line of incision to drain masseter space; 6, ramus of mandible; 7, drainage site for buccinator space; 8, body of mandible; 9, zygomatic arch; 10, site of incision to drain temporal pouches.

The face has several minor groups of glands which in turn empty into larger chains. The deep and superficial vessels from the region of the nose and cheeks accompany the angular and facial veins and end in the submaxillary gland.

The vascular system of the head is very complete and tends to give every part a very rich supply and to provide in health a most adequate venous drainage. The end arteries anastomose freely both with similar vessels across the midline and with their neighbors. This allows ligations to be carried out on many of even the larger vessels without depriving tissues of their nutrition. In the scalp and superficial temporal region the vessels all enter from the periphery passing into the superficial fascia after piercing the deep fascia of adjacent regions. As a consequence of this arrangement, large flaps of the scalp may be torn from the center towards the margin, but so long as they remain attached at the periphery, there is no serious interference with their source of vitality and, if cleaned

and replaced, healing occurs rapidly and satisfactorily, sometimes even without drainage. On the face the overlying skin is firmly attached to the underlying muscles by subcutaneous tissue. This network of fibers in turn envelops the arteries and veins and interferes with their normal ability to collapse and clot. Because of this, bleeding from a lacerated or eroded artery is prone to be profuse and continuous until firmly secured.

It is, however, in our newer knowledge of the anatomy of the venous system that explanations have been made for some of the peculiar extensions of infections in the face. The veins of the face and scalp accompany arteries of like name and normally drain the entire area without difficulty. The veins of the face present a unique anatomical situation for their lack of valves allows a back flow when there is an obstruction. Therefore, pressure from edema or exudate, or a thrombophlebitis which would obstruct the facial vein or its tributaries, would reverse the current of blood. This immediately becomes a most serious problem for, as a result of the anastomosis of the angular vein with the superior ophthalmic, this reversed current will result in infection being carried through the superior ophthalmic into the cavernous sinus resulting in meningitis, sinus thrombosis or bacteriemia. Infections about the upper lip, lower portion of the nares and adjacent cheek are, therefore, always in danger of developing these highly fatal complications.

The ease with which bacterial exudates pass from one area to another or are limited to a restricted space leads us to a most important anatomical study. For these limitations are caused by muscular attachments and fascial planes. The enclosed glands, muscles or bones are of secondary importance as their reactions can easily be noted, but their point of dependent drainage would be unknown without a knowledge of the space within which they are defined.

A correct knowledge of fascial planes now plays an important role in clinical medicine for these planes exert pressure on

swellings that occur in organs which they envelop and thereby influence the shape of these swellings as well as control the pathway of suppuration into contiguous parts. Singer, by means of a new type of dissection, and Coller and Yglesias, by painstaking and laborious efforts have added greatly to our knowledge of these fascial attachments.

The fascia of the head is best divided for description into superficial and deep layers. The superficial fascia is a connective tissue covering for the face and cranium which differs according to the particular region. On the cranium it contains numerous fibrous septa which connect it with the skin and underlying galea aponeurctica. For this reason, incised wounds do not gape and swelling and suppuration are limited. On the face, it sends these same septa into the muscles of expression which are subcutaneous and firmly attached to the overlying skin.

There is no true deep fascia of the cranium but it has a definite fascial space or pocket in which infection spreads. This is in the loose areolar tissue that lies between the galea and the pericranium. This space is formed; laterally, by the attachment of the firm dense galea aponeurotica along the superior temporal line and about the mastoid bone; anteriorly, but its association with the frontalis muscle whose fibers in turn blend with those of the orbicularis oculi; and posteriorly, by its association with the occipitalis muscle that arises from the superior nuchal lines and by its own attachment to the nuchal lines.

Description of the fascial planes of the face is most difficult without the aid of anatomical specimens. If, however, one will visualize a skull with muscles, glands and overlying tissues removed so that only the fascia remains a clearer conception can be obtained as to the limitations of these spaces. Since the fascia envelops the superficial masticatory muscles, the buccinator muscle and the salivary glands, the compartments formed have received similar names. The fascia which covers the buccinator muscle is called the buccopharyn-

geal. This fascia is actually distinct and firm only along the posterior border of the buccinator muscle. There by its firm attachments to the periosteum of the mandible slightly anterior to the angle of the jaw it forms a compartment which limits infections of the body of the mandible from extending backward.

The fascia which envelops the superficial masticatory muscles is divided on their anterior surface by the zygomatic arch into two parts; the parotideomasseteric and the temporal fascias. The temporal fascia springs from the superior temporal line above and after slitting into two layers, extends downward to become attached to the zygomatic arch on two planes. The deeper layer forms the outer covering for the temporal muscle and thus with the skull as a medial boundary, creates a deep temporal space. The two layers and their attachments form the superficial temporal space. These two layers fuse and again pass downward on the anterior surface of the masseter muscle to fuse in the neck with the cervical fascia. This temporal fascia, therefore, forms the anterior boundary of the masticator space and at the same time the posterior boundary of the parotid space.

The parotid space, or the compartment in which the gland is enclosed is formed internally by the fascia overlying the masseter muscle and externally by a thick fascia which originates from the zygomatic arch and extends downward to fuse with the superficial layer of the deep fascia in the neck. The external layer sends numerous septa into the gland substance and thus associates it with the capsule. Anteriorly and posteriorly these fascias fuse to complete the space.

#### SOURCE AND TYPE OF INFECTIONS

Infections gain access in general to the face and cranium by two pathways; (1) by means of preliminary trauma which not only devitalize tissue and provide a rent in the protecting skin but actually carry the bacteria into the wound; (2) through small cracks or openings in the skin itself, by means of which streptococci and staphylo-



cocci as well as contagious organisms gain entrance. In a few instance as, for example, parasites, the infections gain entrance by some other portal. Glandular enlargement and suppuration are in reality a secondary infection as they are the result of bacteria being deposited by the lymph vessels from a primary focus.

The various types of infection can best be discussed by describing particular known diseases. Perhaps the most common infections of the head are those in which staphylococci enter small cracks or infect hair follicles or blackheads. These result in furuncles and boils. They of themselves are of small concern but when the surrounding tissue becomes involved in the form of cellulitis, particularly when they are situated about the nose and upper lip, they present a most grave problem and prognosis. For it is in this situation that thrombophlebitis occurs in the facial vein with a reversed current carrying bacteria into the cavernous sinus. This cellulitis, once it develops, must be differentiated from erysipelas, but this is usually easy because its original site is lower down in the face, and it has a deep brawny edema without definite outline and much pain or tenderness. Treatment of this condition should start conservatively. The pustule or furuncle should never be tampered with or squeezed. Wet dressings should be used in early cellulitis. Once however, marked reaction and swelling are apparent, a small incision should be made to evacuate the collected exudate. If the infection continues and a thrombophlebitis is assuredly present, ligation of the angular vein may be done. However, the use of conservatism plus the occasional use of radium packs and x-ray irradiation seems the advisable procedure. Infections of hair follicles in the scalp, particularly in elderly people who are weakened by some systemic condition, often become serious problems. The occipital region is the site most commonly involved. The ease with which the infection spreads soon allows a small furuncle to develop into a huge carbuncle. This carbuncle is typical in that it involves the

tissues down to the muscle and its extension is only to contiguous tissues. This knowledge is important in the treatment for if surgery is to be employed all the infected tissue must be removed by a circumscribing incision. This operation must take out all tissues down to the muscle. The use of foreign proteins such as horse serum and boiled milk are of great value when conservative treatment is undertaken. The technique of applying them is the same as used in local injections with bacteriophage. This will be described later. Boils of the lower lip are not considered so dangerous as they rarely cause any involvement of the venous flow. They do tend to cause involvement of the submental and submaxillary glands which may need to be incised. Their treatment then is early conservatism plus drainage when the infection becomes localized.

Erysipelas with its red flush, raised irregular edge enclosing islets of normal skin and usually with blisters on the inflamed area is a frequent finding. This disease is caused by a highly contagious bacteria, the *Streptococci erysipela*, gaining admission into the skin itself through some abrasion or crack. When typical, this raised indurated area takes on the shape of a butterfly with the nose and the area between the eyebrows forming the body and extensions on the cheeks, forehead and about the eyes forming the wings. It may be unilateral. The eyelids often tend to become markedly swollen. When the lids and forehead are involved, suppuration frequently occurs. This exudate tends to burrow into the adjacent tissues and as its progress upwards is limited by the close attachment of the frontalis muscle to the overlying skin and by the attachment of the galea aponeuratica along the superior temporal line it tends to extend laterally into the superficial temporal space so that in many cases counter drainage must be carried out as far back as the auricle. The treatment of erysipelas is still varied. Specific antitoxin in 10 c.c. doses should be given intramuscularly for six days unless the temperature breaks. The face should be

covered with warm magnesium sulphate or boric acid compresses. Ointments should be used on the lips and nose to prevent cracking and the general health should be stimulated. X-rays and the ultra-violet lamp have been applied directly to the local lesion but have not given very startling results. The general health must be carefully observed and protected. Abscess formations must be watched for and drained.

Another fairly common infection is that where the lymphatics of the dermis are involved. This is called *impetigo contagiosa*. It is characterized by scab-like lesions which are readily transplanted by scratching. These lesions should be removed with a scalpel or forceps, the tissues washed with green soap and then either painted with iodine or covered with ammoniated mercury ointment.

It is not possible in this short paper to discuss such infections as lupus, tuberculides, primary, secondary and tertiary syphilides, and actinomycosis, but it is well to remember that they all occur. They often spread rapidly and are not usually limited by fascial planes. It is also well to remember that actinomycosis is excellently treated by radium. Acne and tinea occur but they are dermatological problems.

Inflammation of lymph nodes which may result in abscess formation is usually secondary to some septic focus. Those most commonly involved are the preauricular glands found over the parotid, the occipital and the submental glands. Conservative treatment is best and resort to surgery should not be done until definite localization has occurred and pus is obviously present. This can be determined by a softened area and the presence of fluctuation. Drainage through a small incision as near as possible to a normal skin fold will usually suffice. It is always well to search out the primary focus and treat it.

Acute suppurative parotitis is a severe and grave condition accompanied by great pain and marked swelling, and later edema of the eyelids. This pain is due to the dense fibrous covering of the gland which so

completely walls it in that even fluctuation can not often be detected until death from sepsis may occur. In debilitated patients it may be a bilateral infection and then it has a grave prognosis and is usually a terminal event.

Infections of the parotid gland may result from the obstruction of its duct by a calculus or edema or more frequently as a spontaneous complication of operation. The gland may also be infected by rupture of an abscess in an adjoining fascial space either deep or lateral to it. Why infections occur in the parotid glands as a complication of operation is still unknown in spite of the various theories that have been advanced. However, most authors agree that bacteria enter the gland either by passing through Stenson's duct or through the blood stream.

This condition usually occurs in patients who become markedly dehydrated, seriously ill and have poor oral hygiene, following severe abdominal and genitourinary operations. It is prone to follow a dry mouth, the result either of improper fluid intake or the drying up of salivary secretion as a result of drugs.

The diagnosis is usually easy because of the severe pain and swelling and the characteristic edema of the eyelids. However, early in the disease, abscesses pointing near the gland from surrounding spaces must be ruled out for rupture of an abscess, either in the masticator space which is posterior to the gland or the rupture through into the gland of a peritonsillar abscess which points ordinarily in the lateral pharyngeal space, may simulate it.

Prevention of this condition should be the goal of all surgeons and following operations measures which aim to stimulate salivary secretions should be undertaken. Frequent mouth irrigation, the use of chewing gum, rock candy and all day suckers are of great value.

However, once the diagnosis has been made, active treatment must be instigated. Hot or cold applications are advocated depending on which one is best tolerated by the patient. Conservatism in the first

few days seems indicated. X-rays and radium packs are now accepted treatment during this period and probably afford more relief and result in more cures than any other method. If, however, on the third day definite improvement is not noted, drainage is imperative. The technique described by Blair, although radical, is adequate. The incision "starts two centimeters in front of the ear and then downward to behind and below the jaw. A flap of skin and superficial fascia is stripped off the whole gland and its parenchyma punctured and torn in numerous places." The gland substance should never be cut with a knife as the facial nerve would be injured. The deep portion of the gland and its posterior surfaces can be exposed by elevating the lower pole.

Wounds of the face and scalp, when they involve the deeper layers, tend to become infected. This infection is then limited only by the facial or muscular attachments. Incisions to drain suppurative accumulations should parallel their limiting attachments. Deep wound infections of the scalp tend to extend beneath the galea and point posteriorly along the superior nuchal lines because their lateral extension is limited by the attachment of the galea to the superior temporal lines.

A wound infection or a ruptured abscess in the superior or deep temporal space will usually point just above the zygoma and incision should be made at this point. When the infection extends downward into the masticator space or when this area is primarily involved, pointing occurs at the anterior border of the muscle and this region should be used for drainage.

In the description of the treatments used in the various infections discussed, bacteriophage has not been mentioned. This is because its place has become so important in the treatment of furuncles, boils and carbuncles of the head that it deserves special space. MacNeal has contributed much to the action and uses of bacteriophage and is now even more enthusiastic. He believes from his experience that all furuncles and carbuncles of the head due to

staphylococcus should be treated with bacteriophage routinely and that surgical incision should be delayed until it has been given a trial. It is well to remember that if this form of treatment is to be used it must be done thoroughly with the correct phage or no benefit can be expected.

The procedure that has proved most successful is, (1) to inject 2 c.c. of the bacteriophage intravenously each day; (2) to needle the area around the furuncle or carbuncle with enough bacteriophage to blanch the skin at each injection; and (3) when the infection has pointed and opened to actually flush through this opening from the outside areas large amounts of the bacteriophage. A stock staphylococcus phage is used until the specific one is obtained from cultures taken when the patient was first seen.

#### SUMMARY

1. Mention is made of the historical knowledge of head infections.
2. The anatomy of the vascular system with its abnormalities is described.
3. The attachments of muscles and fascia of the head are described and the effect they have on limiting the extension of infections is discussed.
4. Common infections are described and their treatment outlined.
5. Bacteriophage in the treatment of head infections is described.

#### REFERENCES

- BAILEY, H. Ligation of the angular vein as a preventive measure in facial carbuncle. *Surg. Gynec. and Obst.*, 46: 565, 1928.
- BLAIR, V. P. and PADGETT, E. C. Pyogenic infection of the parotid glands and ducts. *Arch. Surg.*, 77: 1, 1923.
- COLLER, F. A. and YGLESIAS, L. Infections of the lip and face. *Surg. Gynec. and Obst.*, 50: 277, 1935.
- CUNNINGHAM. *Textbook of Anatomy*. Baltimore, Wm. Wood & Co.
- GARRISON, F. H. *History of Medicine*. Phila., W. B. Saunders & Co.
- MACNEAL, W. J. The use of bacteriophages in wound infections and in bacteremias. *Am. Jour. Med. Sc.*, 184: 805, 1932.
- MITCHNER, P. H. Infection of the face and lips. *Practitioner*, 136: 367, 1936.
- SINGER, E. *Fasciae of the Human Body*. Baltimore, Williams & Wilkins, 1935.

# MALIGNANT TUMORS OF HEAD

GEORGE A. WYETH, M.D.

Director, Cancer Research, St. Clare's Hospital, New York; Consulting Surgeon, Grasslands Hospital, Valhalla, N. Y.

NEW YORK

**K**NOWLEDGE of the nature and characteristics of malignant lesions of every kind has steadily increased as the pathologists press forward in research, and progress in the treatment of these lesions should follow the increase in definite knowledge of their nature and characteristics.

Ever since Broders established his classification of tumors into Grades I, II, III and IV on the basis of the degree of differentiation it has been possible for the practitioner in charge of cancer cases to know, *before beginning treatment*, (1) what kind of a tumor it is, (2) what is its degree of malignancy, and (3) whether it is radiosensitive or radioresistant.

This definite knowledge should put an end to the automatic application of one kind of treatment for all cases. Obviously, the radiosensitive tumor (Grade III or IV) should not be excised by scalpel and the radioresistant tumor (Grade I or II) should not be treated by x-ray or radium.

In our opinion the office use of the microtome represents the greatest step forward in the treatment of cancer that has been taken in a decade. As proved by the work of William C. MacCarty, of the Mayo Clinic, this procedure in immediate diagnosis is so perfected that within five minutes from the time the biopsy specimen is taken the tissue can be frozen, a stained section placed under the microscope, and the pathological diagnosis and classification definitely established.

Since the announcement of this important advance the writer has had in his office a microtome and a tank of carbon dioxide for the making of frozen sections. By the biopsy electrode it is now a simple matter to remove a cube of tumor tissue, and I have

yet to see any unfortunate results attributable to biopsies made in this way. It does not require a great deal of pathological knowledge or experience to be able to distinguish a highly differentiated adult, squamous, radioresistant tumor from an anaplastic, radiosensitive tumor (Fig. 1).

Fortified by full knowledge of these recent advances in cancer technique, the surgeon will lose no time in referring for irradiation every case of anaplastic, radiosensitive tumor, except the basal cell epitheliomas. He will follow this irradiation with electrosurgical removal of the residue of malignant tissue, should any remain.

Since the fully differentiated, adult, squamous cell carcinoma is radioresistant it must be given repeated doses, or a cauterizing dose, which causes it to break down and slough. By electrosurgery, the surgeon can destroy and remove in a single treatment, covering only a few minutes, a lesion the successful irradiation of which would require many weeks.

Mindful of the subject assigned him, "Malignant Tumors of the Head," the writer would, first, indicate briefly certain facts which bear upon the applicability of electrosurgery to office cases.

Because each of the three currents is easy of application and is clean in its results, each has an especial usefulness in office work.

The lightest current, the monopolar or desiccating, is the one most often used. For the removal of angiomas, papillomas, warts, moles, pigmented nevi, fibromas, leukoplakia, polypi, epuli and other blemishes this is of all treatment methods the one of choice.

Removal can be begun and finished in a single application.

In proper use, under local anesthesia,

penetration, it is so completely under the control of the trained operator who knows his machine and the characteristics of the

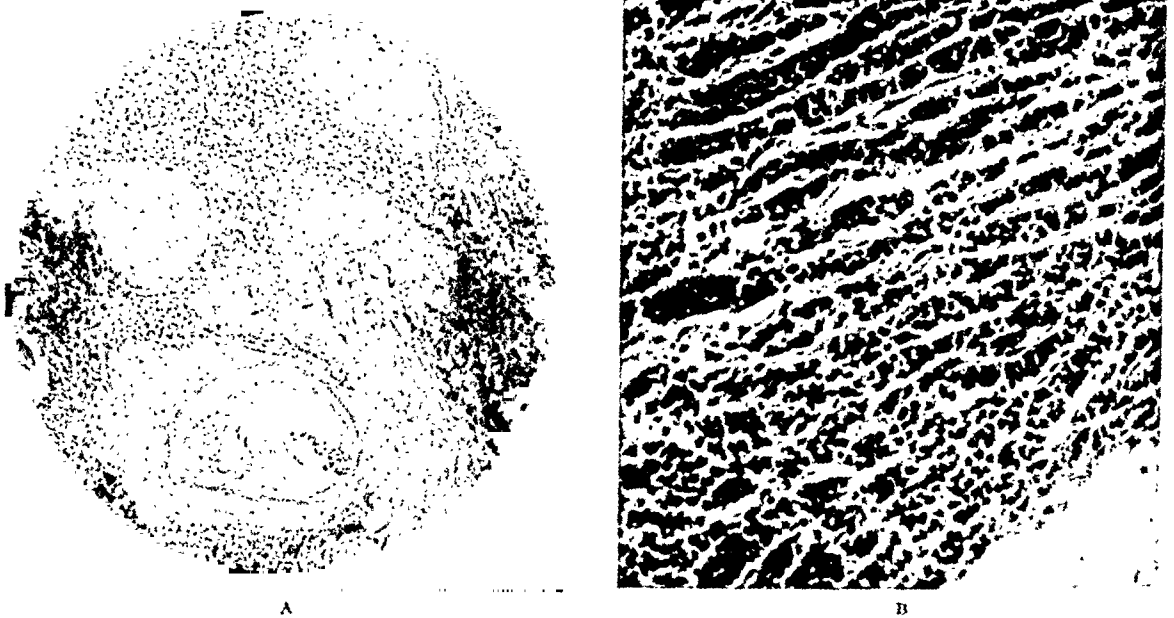


FIG. 1. Microscopic pictures illustrating difference between A, Grade 1 fully differentiated, squamous cell carcinoma, and, B, Grade IV, anaplastic carcinoma.

desiccation is painless; its sealing of superficial blood vessels prevents hemorrhage and produces a minimum of secondary reaction. There is, therefore, a superior cosmetic result with none of the scarring which follows scalpel excision. Because the neoplastic tissue is removed as a dead mass, however large or small it may be, the possibility of recurrence and metastasis is lessened.

For a long time the teaching was that such superficial lesions, such "blemishes," should be let alone until they became active. Since the perfection of the surgical use of the monopolar current, however, it is clear that by removal of "precancerous conditions" it is possible to prevent their becoming active.

The second electric current used in surgery is the bipolar or coagulating current. In tissue treated by this current the cell outline is lost, the elements being fused into a structureless, homogeneous mass. The result is coagulation necrosis. Although this current is applicable to lesions calling for more extensive destruction and a deeper

current that it may be used in office routine for the treatment of many cases which would otherwise need hospitalization.

The third electric current used in surgery is the cutting current. Its perfection was reported by the writer to the Surgical Section of the New York State Medical Society, meeting in Rochester, in April, 1924.

We may say here merely that the qualities inherent in the other currents—the monopolar or desiccating and the bipolar or coagulating—give to the patient treated by the cutting current, the endotherm knife, a great measure of protection against shock, against hemorrhage and against the threat of recurrence or metastasis. It seems scarcely necessary to emphasize the fact that these qualities very especially adapt electrosurgery to office use. Let me illustrate by the case of M. M. a patient of the Cornell Clinic.

CASE 1. The patient was a young woman of twenty-five years who was suffering from a cerebelliform melanoma of the scalp (Fig. 2A). The lesion was growing and its immediate

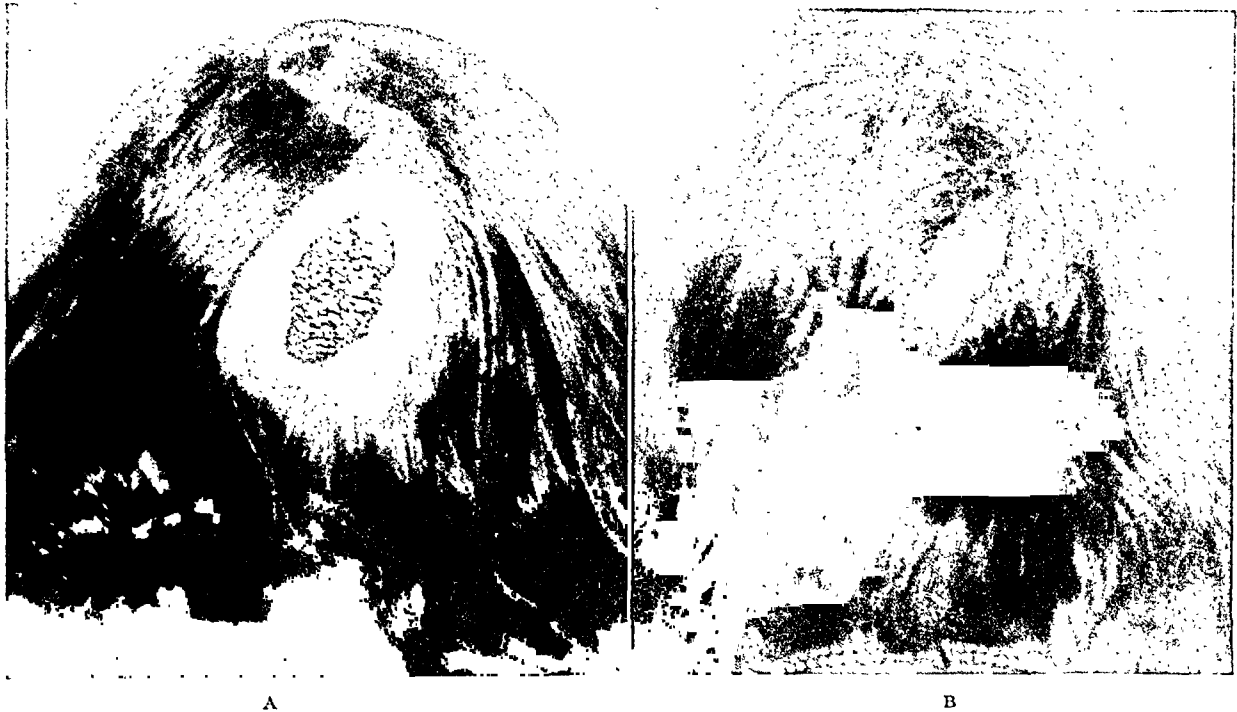


FIG. 2. A, cerebelliform melanoma of scalp excised by cutting current; B, soft pliable healing. No apparent metastasis or recurrence in seven and one-half years.

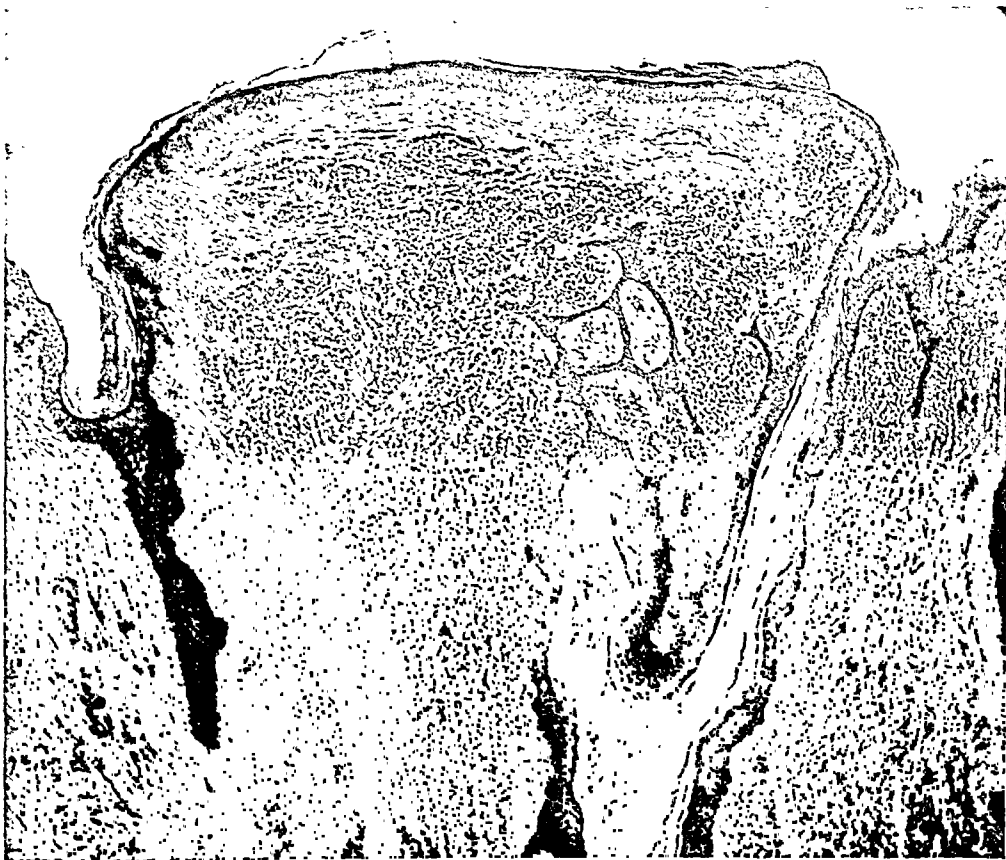


FIG. 3. Photomicrograph showing widespread distribution of melanin granules.

excision was advised. Melanoma is one of the most virulent and highly malignant lesions, but as it is known to be radioresistant, irradiation

tissue remains. There is reason to believe that the gradual absorption of this remaining bit of coagulated tissue which goes on

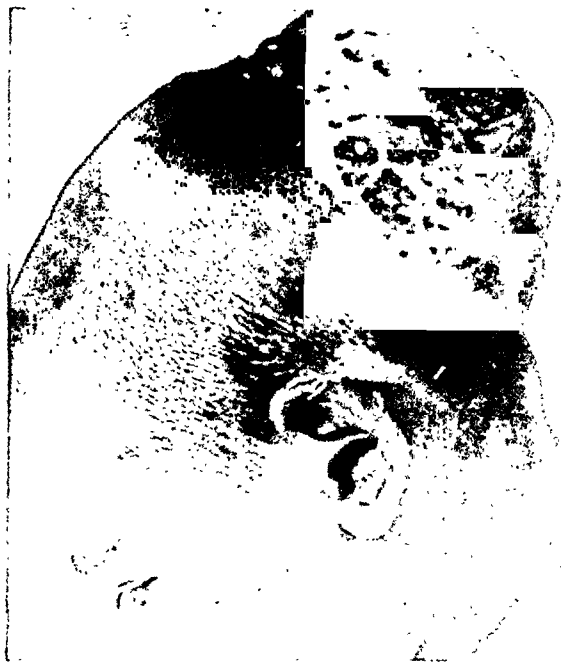


FIG. 4.



FIG. 5.

FIGS. 4 and 5. Fibro-angiosarcoma of scalp before excision by electrosurgery.

should not be prescribed. The choice of means of removal lies between the scalpel and the endotherm knife or cutting current. Any surgeon who has had experience with scalpel excision of melanomas will wish to use the other method.

On March 20, 1924, under local anesthesia, the cutting current excised the lesion without hemorrhage. The sutured wound healed by primary union and the result was a smooth, pliable scar (Fig. 2B).

Examination established the diagnosis of cerebelliform melanoma of the scalp (Ewing). The photomicrograph of the lesion (Fig. 3) shows widespread distribution of melanin granules.

The patient lived more than seven and one-half years and died in one of the larger hospitals of the city following a *pneumothorax* operation for "pulmonary tuberculosis."

The intense heat produced by the resistance of the tissues to the passage of the many oscillations of high frequency current sterilizes the lesion. After its removal a thin, healthy film of coagulated

in the sloughing process acts as a foreign protein to the reticulo-endothelial tissue and thereby accounts, in some measure, for the feeling of general well being which the patient experiences immediately after the use of electrosurgery. It would be difficult to prove this connection but the writer has so often observed it he cannot consider it accidental. It presents itself as a clinical fact offering a field for scientific investigation.

Readers of the American Journal of Surgery will recall that in Report No. 34, issued by the British Ministry of Health on "The Late Results of Operation for Cancer of the Breast," it was pointed out that 90.1 per cent were alive ten years after operation if growth had been limited to the breast, and that 91.3 per cent were dead in ten years if the axillary glands had become involved before the date of operation. May I here make mention of a case of fibro-angiosarcoma of the scalp which, excised by electrosurgery, shows no evidence of

recurrence almost twelve years after operation although there was considerable glandular enlargement at the time the case was first brought to our attention. In our opinion, report of this case has place in this paper although it was treated in the City Hospital and not in the writer's office.

CASE II. At birth the child, R. A., had shown nothing abnormal except a black mark about 2.5 cm. in diameter, on the back of the scalp.

At the time the writer first saw her the child was five years old and the scalp growth was as illustrated in Figures 4 and 5. Glands of the neck were enlarged. There was no apparent tenderness, the lesion was movable within the normal range of scalp mobility and did not appear to be attached to the structure of the cranium. X-ray pictures showed no destructive or productive changes in the vault of the skull; the inner and outer tables were all of normal thickness and there was no evidence of pressure. The heart and lungs were normal, as were the abdomen, extremities and reflexes.

On June 27, 1925, the growth was excised by the cutting current with but little hemorrhage and no surgical shock. The skin over the



FIG. 6. Growth excised in one piece by cutting current.

glands in the neck was then undermined with the cutting current, and the glands themselves were coagulated by the bipolar current and left in situ to be absorbed.

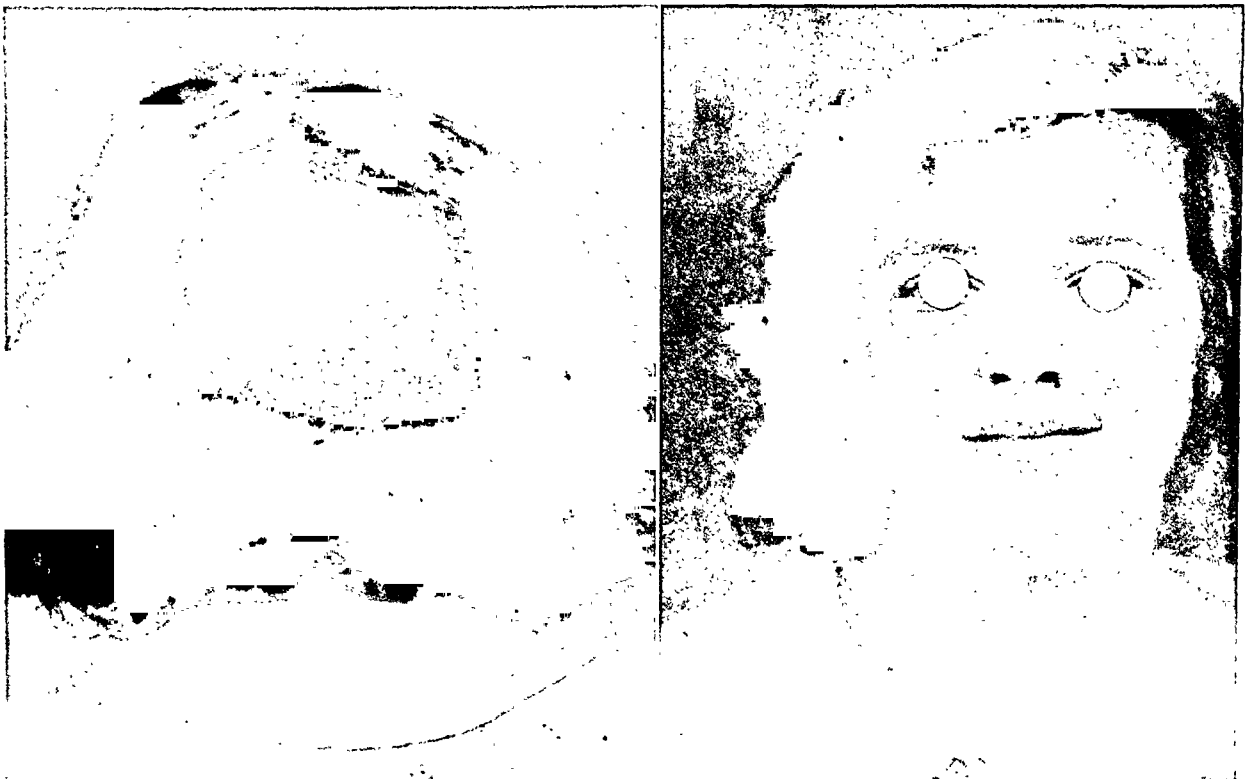


FIG. 7. Appearance of patient almost twelve years after removal of fibro-angiosarcoma of scalp.

The lesion had been treated with radium for more than a year but no one had attempted removal by the scalpel.

Since the operation there have been frequent examinations, but never any evidence of metastasis or recurrence. The patient is now



a normal, happy school child, as shown in Figure 7.

Detailed mention of this case is important in connection with any discussion of tumors of the head for more reasons than have yet been given. It illustrates the fact, not well enough known, that not every enlarged gland in a case of cancer is malignant. So often has this fact been proved by the microscope that the writer has discontinued the routine bloc dissection as unscientific and unwarranted. If glands are not malignant their removal is not necessary. If they are malignant, their removal does not seem always to prevent recurrence. The presence of enlarged glands, therefore, should not of itself preclude operative interference by newer methods.

#### SUMMARY

This article establishes the relationship which knowledge of the nature, characteristics and treatment of malignant lesions should bear to the forward steps of pathologists' research and to the institution of treatment. MacCarty's work on the differentiation of tumors together with the office use of the biopsy electrode and the microtome, has made possible the practitioner's classification of tumors and the choice, before treatment is begun, of the proper measures to be taken in each individual case. The nature of the three high frequency currents employed in electrosurgery, their advantages and their separate applicability to office procedure in different grades of malignant tumors is outlined, and 2 case reports cited.



# ANGIOMATA OF SKELETAL MUSCLE

H. B. THOMAS, M.D.      AND      F. W. HARK, M.D.

Professor of Orthopedic Surgery      Assistant Professor of Orthopedic Surgery  
University of Illinois, College of Medicine

CHICAGO

**A**NGIOMATA of the muscle are considered rare tumors; they have been found in the bones in only 10 per cent of autopsied material. The abundance of recent reports on angioma of the muscle suggests that they might be more common than the early reports would indicate.

Angioma or hemangioma is an abnormal dilatation or overgrowth of blood vessels. They are considered by some to arise from lymph spaces and that the presence of blood in them is more or less accidental.

There are considered to be three types of angiomata: (1) simple, (2) plexiform, and (3) cavernous.

The simple angioma is a congenital dilatation and overgrowth of capillaries. Its independent existence is denied by some authors who maintain that they are simply a step in the development of the cavernous type.

Plexiform angiomas are overgrowths of capillaries and venules in length and thus pile up nodules of vessels which may acquire considerable size. They do not destroy other tissues.

The cavernous type is an overgrowth or hyperplasia of existing vessel walls with a gradual disappearance of the intermediate tissues through atrophy, thus forming cavities.

## ETIOLOGY

Of the many theories the following two receive the most support. Angiomata are considered to have their origin in a congenital anlage which after a trauma begins to proliferate and develop into a tumor (Ribbert) or existing vessels dilate and proliferate after a time, some of the walls becoming atrophic, disappear and allow the

sinuses to develop (Virchow). Trauma is considered as the starter in both theories.

All are agreed that they are congenital. Fitzwilliams found that 83 per cent were present at birth, 12 per cent appeared during the first three years of life; 16 per cent volunteered a family history.

## PATHOLOGY

These tumors are usually described as being bluish-red to yellow in color. They may be soft or quite firm depending upon the ratio of vascular to fibrous tissue. The tumor may be circumscribed or diffuse. If the latter, muscle invasion will be observed even to the extent of replacement. Nerves and blood vessels may also be invaded.

Microscopically, the tumor is composed of numerous blood filled spaces lined with endothelial cells. These spaces are supported by a variable amount of connective tissue, the amount determining the consistency of the tumor. Thrombosis of the spaces frequently occurs and is followed by organization and the further formation of connective tissues. This process may become extensive enough to halt the progress of the tumors. Myelated and unmyelated nerve fibers sometimes appear in the tumor.

## SYMPTOMS

Pain is the chief complaint and may be of three types: (1) a feeling of fullness which is probably due to engorgement and can be relieved by elevation of the leg; (2) a radiating pain similar to a root pain and is probably caused by pressure on or infiltration of the sensory nerves; and (3) sensitiveness to touch. This type of pain is

explained by irritation of new nerves which are sometimes present within the tumor or to the presence of angiolithic concretions.

Pain is more prominent when the tumor is in muscles that lie close to nerves as in the thin muscles of the extremities than in the thicker muscles of the trunk and neck. It may be present only when the muscle is being used and absent when the muscle is relaxed. There may be numbness or formication.

Another symptom is impairment of function. It may vary from slight limitation of motion to a contracture, or from slight weakness to almost complete loss of function. This may be due to the pain or physical presence of the tumor which prevents contraction, or from weakness because of destruction of muscle tissue and replacement by tumor tissue and fat.

Swelling is the only sign of which the patient complains. This may be ill-defined and appear at any time and it may remain stationary or gradually increase. Sometimes it may be noticeable only after prolonged use of the involved muscles and disappear after rest. Then again the swelling is only found at time of operation. It is good to bear in mind a sign Davis called attention to, i.e., varicose veins in a child should suggest a deep seated hemangioma. One of Kidner's cases had associated varicose veins.

The roentgen ray usually brings out only a soft tissue swelling. Occasionally the large blood spaces give the appearance of gas in the tissues. Occasionally there may be the characteristic angiolithic concretions (Ruggles). They consist of a thin shell with an irregular center. They are thought to represent calcified thrombi.

The diagnosis is seldom made preoperatively. A hemangioma should be considered when the tumor decreases in size on elevation, if normal blood is withdrawn at aspiration and the tumor fills again within a very short time, and if the x-ray film shows the millet seed concretions. The history of the case, its time of appearance and duration, early lack of symptoms, and

their type as given should be taken into consideration.

Arteriography has been of no value to us either in diagnosis or in outlining the course of treatment, because there are no afferent or efferent vessels.

#### TREATMENT

Excision was considered the treatment of choice in both of the cases herewith reported as well as the 2 cases previously reported. Excision is relatively easy when the tumor is small but it presents great difficulties in the larger tumors which involve a considerable portion of a group of muscles, nerves or blood vessels. In such cases other methods may be employed to save the affected limb from amputation. Compression of the angioma, ligation of the arteries which nourish the tumor and treatment with x-ray or radium may be tried.

**CASE I.** As this paper goes to press a girl of about seven years of age entered the clinic because of an ulcer on the mid-third of the anterior surface of the tibia following a bruise against a rocking chair. She gave the history of having a tumor the size of an orange in this area since birth which her doctor cured by means of a pressure bandage. There was an area around the small ulcer about 3 inches in diameter which contained little subcutaneous fat and the skin contained fine red spots suggestive of a hemangioma. A biopsy proved this to be the case. It did not seem to penetrate the vaginal fascia. Reports of similar treatment of muscular angioma, however, are not so favorable. Ligation is not considered favorable as there is no single vessel nourishing the tumor. Radium or deep x-ray therapy are most promising. Both have helped to reduce the size of the tumor.

The histories of 2 patients with angioma of voluntary muscles are given to emphasize the characteristic symptoms of the disease, to stress the functional disability and the difficulty in overcoming it.

**CASE II.** T. H., aged fifteen years, presented herself in August, 1935, because of a painful mass, of eight years duration, in the back part

of her left leg above the ankle. At the age of seven years, the patient jumped over a fence, fell and twisted her left leg. The leg hurt continuously for several days, then irregularly for six months when a mass appeared in the calf. This mass gradually increased in size and extent for two years. Since this time it was stationary but would swell when the patient walked excessively. She stated that she lost many nights sleep because of the pain in her legs. The leg was less painful when the patient was at rest, and quite painful for hours upon lying down after exercise.

Physical examination revealed nothing of interest except for the swelling in the lower left leg posteriorly. The narrowness beneath and the curve of the Achilles tendon was obliterated by a tumor mass more or less firm, quite tender to touch, and about 20 cm. long and 10 cm. wide. It seemed to be a part of the gastrocnemius, and the Achilles tendon.

This mass was explored October 24, 1935, through an incision 15 cm. long centered over the posterior surface of the leg 6 cm. above the os calcis. A firm, vascular grey pink irregular tumor 7 by 3 by 1.5 cm., which seemed to arise from the anterior part of the gastrocnemius muscle with downward extension and was adherent to the Achilles tendon, was excised. This was difficult because of the vascularity and the diffuseness of the tumor.

The wound healed primarily and the patient was discharged.

*Pathological Report.* "Cavernous Heman-  
gioma." "The tumor mass has yellow to orange colored tissue containing numerous small blood spaces. It has no capsule.

"The microscopic sections shows a background of muscle heavily infiltrated with fat. There was also focal areas of round cells.

"Scattered about are large blood filled spaces lined by endothelial cells. These are numerous, and in areas reach large proportions. These are also connected by long slender channels from one space to another.

"The surrounding musculature as a result has undergone atrophic changes, is a pale pink in color, the individual muscle bundles of a given area being fragmented and amorphous in appearance. In contrast an area immediately adjacent may have few bundles of muscle in a fairly good state of preservation."

She continued to have pain and was developing an equinus deformity, so she was

readmitted to the hospital March 31, 1936 for further surgery.

The same incision was used. At the upper end of the tumor three branches from the posterior tibial artery were found to enter the tumor mass. A tumor 5 by 4 by 3 cm. was excised from the lower end of the gastrocnemius. The flexor hallucis longus was also found to be involved.

The wound healed primarily.

It was thought at the time of the first operation that all the tumor tissue was excised. This case raises the question of a malignant nature in that it tends to recur locally.

H. B., colored, aged seven years, came to the clinic July 29, 1935 because of a limp of nine months duration. She complained of pain over the back of the knee when touched. Physical examination was negative except for a moderate flexion contracture of the right knee. Inspection revealed no tumors. The posterior surface of the lower thigh and popliteal space was so sensitive that the child screamed when touched even lightly. The temperature was 99.5°F.

Radiogram showed irregular calcareous shadows in the soft tissues of the leg just below the knee joint. Nature—angioma? malignancy?

On February 24, 1936, under anesthesia, one could feel three distinct tumor masses, the first posterior to the upper end of the tibia, the second in the muscle tissue apparently in the lower end of the inner hamstrings, and the third about midway along the thigh posteriorly apparently in the muscle tissue. The first tumor involved the posterior tibial nerve. To remove it would have meant to remove the nerve. Cutting into it longitudinally the knife grated because of the calcareous material. The second tumor was in the lower end of the semimembranous muscle. It was resected and the healthy distal end of the muscle sutured to the semitendinosus. This tumor was firm, grayish-pink, quite vascular and 8 by 3 by 2 cm. in size.

The pathological report was essentially the same as for the other case.

These 2 cases are of interest because the symptoms of the one are typical of an angioma history and the second case because

of the concretions which brought the diagnosis of angioma into consideration.

#### SUMMARY

Functionally, angiomata may be considered as malignant vascular tumors. Pathologically, there are simple, plexiform, and cavernous types. Pure types of the first two are not often seen, which suggests to some that they are a stage in the development of the cavernous type. The symptom of pain, and the sign of swelling are the patient's complaints. The treatment of choice is radical resection. In the extensive ones, x-ray and/or radium application may retard the growth sufficiently to avoid amputation or prolong the time before it becomes necessary.

#### REFERENCES

- BAILEY, P. Cavernous hemangioma of vertebra. *J. A. M. A.*, 92: 1748, 1929.  
BUCY, PAUL and CAPP, CHARLES. Hemangioma of bone. *Am. Jour. Roentgenol.*, 23: 1, 1930.  
BURMAN, M. and MILGRAM, J. Hemangioma of tendons and tendon sheaths. *Surg. Gynec. and Obst.*, 50: 397, 1930.  
DAVIS, J. S. and KITLOWSKI, E. A. *Arch. Surg.*, 20: 39, 1930.  
IRELAND, JAY. Hemangioma of the vertebra. *Am. Jour. Roentgenol.*, 28: 376 (Sept.) 1932.  
JOHNSON, H. Calcifying hemangioma. *J. A. M. A.*, 90: 1108, 1928.  
KIDNER, FREDERICK C. Diffuse cavernous angioma of the leg. *Surg. Gynec. and Obst.*, 63: 647, 1936.  
KLEINBERG, S. Angioma of the leg. *Ann. Surg.*, 91: 317, 1930.  
RUGGLES, H. E. Calcification in angiomata. *Am. Jour. Roentgenol.*, 6: 512, 1919.  
THOMAS, H. B. Angiomas of skeletal muscle. *Am. Jour. Surg.*, 31: 354, 1936.  
TRAUB, E. F. Should vascular nevi be treated? *Arch. Ped.*, 50: 273, 1933.



# INFECTIONS OF NECK\*

DENVER M. VICKERS, M.D., F.A.C.S.

Attending Surgeon, The Mary McClellan Hospital

CAMBRIDGE, NEW YORK

**I**NFECTIONS in the neck occupy a considerable proportion of the office time of the practicing surgeon. Between the skull and the scapula, or between the mandible and the clavicle, are contained much concentrated anatomy and in this area are seen inflammatory lesions that may be occasionally serious, but always painful and inconvenient.

In the cervical region, there is a great group of rather routine lesions, and a few unusual ones. But on the surgeon's skill in diagnosis and treatment depends not only the health, but also the appearance of the individual.

Aside from all matters of safety and comfort, the girl will forever appreciate the doctor who leaves her neck with a small and inconspicuous scar, and will frequently blame the surgeon instead of the disease, if the scar happens to be wide or ugly.

Of the superficial group of infections, impetigo is rightly due to the dermatologist, but often comes to the surgeon, and is of diagnostic importance. The scattered appearance of the honey colored crusts, and the chronic, intermittent story, usually are typical. It can be easily cured by detailed cleanliness, and some mild antiseptic as the ammoniated mercury ointment of the U.S.P.

Erysipelas should be relegated to the same specialty but even in textbooks, the disease is given to the surgeon. This has considerable morbidity and mortality. It usually starts around the orifices; usually occurs in persons under par generally; is associated with high fever, and tends to run a spontaneous course. Specific anti-streptococcus serum is invaluable in the treatment, but must be given in adequate doses and repeated till effects are obvious. Ultra-violet light, given long and often enough to produce a mild erythema, is useful. Local

lotions and applications, we keep as simple as possible.

The ordinary furuncles and boils are treated as they would be elsewhere, with this emphasis; be entirely gentle in the manipulation of inflammatory lesions about the face and neck. Many of the larger boils can be evacuated gently through a small incision, and under the influence of wet dressings will heal with small scars. Teach your staff and your patients not to squeeze boils about the neck.

Intermediate between this superficial group of infections, and the deeper, is a more dangerous one; Ludwig's angina, a "phlegmon" or septic adenitis. This is a diffuse inflammation of both the superficial and deep tissues of the neck, following the fascial planes, usually after some inflammation about the throat or mouth, or some slight abrasion of the skin. The tissues rapidly become boggy, edematous, thickened, in the beginning without the formation of real pus. The patient shows a high fever and signs of general prostration. In a rather high percentage of cases, there is a fatal termination.

The condition was first described a hundred years ago by D. Ludwig and cases occur frequently enough so that every active surgeon sees one at intervals.

Ludwig's angina is, therefore, a difficult and dangerous disease. Be on the watch for it and give your prognosis accordingly.

The term probably covers a group of infections which may extend from the mucous membranes, deep along the lymphoid tissue of the pharynx, and produces a diffuse swelling and hypertrophy of all the lymphoid and areolar tissue of the neck with almost explosive suddenness.

With other cervical infections, one can temporize, while considering diagnosis and treatment. But in true Ludwig's angina,

\* From the Mary McClellan Hospital.

the patient is often better or worse before cultures and detailed laboratory reports can be obtained. Here the surgeon must depend on his own clinical observation guided only by his training and experience.

Treatment is notoriously difficult. Entire conservatism, with the application of wet dressings, poultices or local applications, often leaves the patient increasingly toxic, and he may die from extension into the mediastinum or from pressure on the deeper structures of the neck.

Incision and drainage usually fails to find definite pus, and the surgeon rests in the hope that the release of pressure on the fascia may accomplish some good, or that the outlet for serum may allow the pus to drain if, as and when it forms. But the decision for or against open surgery must be made quickly.

Carbuncles, of the deeper lesions, are most typical on the back of the neck, where the thick layers of fascia subdivide the subcutaneous and ligamentous layers between the spine and the occiput.

The clinical history usually begins with a small abrasion, a boil or a furuncle, which is rubbed by the collar or squeezed manually, and failing to resolve, becomes increasingly inflamed. By the time the patient reaches the surgeon, the infection has spread wide beneath the exposed area, and has burrowed deep in the fascial planes on the posterior aspect of the neck.

Diagnosis is usually obvious. But be sure of complications. Work the case up thoroughly before you start and make sure that the patient has not some systemic disease as well. Occasionally, the presence of sugar is discovered only after the lesion fails to heal, to the discomfort of both the patient and the surgeon.

The conservative treatment of carbuncle is worth trying in selected cases. Short, fairly frequent, x-ray treatments, with a low voltage, i.e., from 60 to 80 kilovolts, and a light aluminum filter, may effect results, with a minimum scar. With this, or as a means in itself, you may use non-specific protein therapy, with typhoid vaccine or sterile milk injections. Avoid the ointments and oily applications. Saline

dressings, or hypertonic solutions, or the mixture of glycerine and magnesium sulfate give great relief, and are worth the trouble they cause.

But, don't be too set in your scheme. If this does not prove effectual in a few days; if the lesion is not definitely improving; change your mind and turn to surgery.

Surgery of a carbuncle should be radical. Use anesthesia enough to accomplish what you have to do. Local anesthesia is difficult and may spread infection. General, such as nitrous oxide or ethylene, is easier for patient and surgeon. Skin preparation should be ample. During the stage of healing, you will bless the wide area of shaving.

Incision should be crucial and should extend to normal tissue on all sides. Dissect back the corners of the flaps, so that the infected tissue is exposed and drained from beneath.

Probably some of the flap will slough off, but the main portion of it will be saved, and you will be thankful for this in the weeks you are waiting for the lesion to heal.

Reserve the operation of complete excision for those very toxic cases, where you must get rid of the infection quickly.

So, go wide and deep, and dissect with scissors far enough to lift the flaps free, so that you can see normal tissue. Do it at the first operation and save yourself a second trip. Then pack the flaps wide open with vaseline gauze, or gauze soaked with the 50 per cent mixture of magnesium sulfate and glycerine.

At this stage, large moist dressings give great comfort, or daily applications of ultra-violet light, but keep the packing in, and allow the clean granulations to push it out. Then when the cavity is clean, which may be in two weeks or six, allow the flaps to come together, or even pull them together with narrow strips of adhesive. The scar will look much smaller when you get through than you ever could imagine in the beginning.

Another great group of inflammatory lesions are those associated with diseases of the lymph nodes. The most common one is the mild or more severe lymphadenitis that occurs with a sore throat or an infected

tooth, most commonly in children, but also in adults. These clear up with healing of the primary focus. They require no specific therapy, beyond the local, symptomatic warm, moist applications. Encourage your patients not to rub them with the thousand and one things they read about in the lay press.

Chronic swelling of the glands of the neck, again most commonly seen in children, is generally tuberculosis, whether definitely proved or not. Most of these are probably bovine, through infected milk. Certainly we seem to have seen fewer cases since herds have been tested and milk more generally pasteurized.

These give a clinical history of glandular enlargement after an acute upper respiratory infection, but the glands persist after the infection in the throat has subsided. Then they gradually grow larger over a period of weeks; become moderately tender and painful, and adherent to the skin and underlying tissues. They have a characteristic texture, so that trained fingers may make the diagnosis by the sense of touch.

If the individual gains in weight and strength, the glands may gradually become smaller. If on the contrary, the infection gets the upper hand, the glands will increase in size and even become fluctuant. At this stage, they may be very large, and cause torsion of the head and neck.

These broken down nodules are apt to break to the surface and drain. The period of drainage is long, and the abscess cavity is continually reinfected with the usual pyogenic organisms introduced from the outside.

Treatment of tuberculosis of the lymphatics undergoes periodic changes. Recently Miller and others have advocated again the more complete dissection of the neck. The basic idea seems logical; that by complete removal of the focus of infection before the glands break down, you might remove the tubercle bacillus from the body entirely and prevent infection spreading elsewhere, especially to the lungs. But this operation, if done at all, must be complete,

and of course is not an office procedure. The surgeon must know his anatomy, and make a large enough incision to visualize the structures with which he is working. The incision heals with a narrow scar.

But the conservative methods, too, give results. It is argued that this small and usually well controlled site of infection "vaccinates" the body against the tubercle infection elsewhere. Usually the glands gradually do become smaller and usually do not break down.

So, the alternate scheme is to endeavor to build up the patient's general health, with such measures as rest, fresh air, good food, sunshine, or local ultra-violet light. Even then, there may be some small nodules which remain for years.

If fluctuation or suppuration occurs, open and drain through a small incision, or aspirate through a large needle. Aspiration has the advantage of avoiding secondary infection, but it is sometimes impossible even with a good sized needle.

But open before the lesion breaks. This gives you an opportunity to plan the line of incision, so that it runs with the line of fold of the skin of the neck. A spontaneous opening is apt to leave a large and ragged scar which will persist through life.

Any method must control foci of infection. Adenoids and tonsils, or infected teeth must be adequately cared for or removed if advisable.

Remember that the conservative method does not mean sitting back and praying. The regime of forced nutrition must be real. Measures must be planned in whatever economic strata the patient is found. For the maximum result, it is well to keep the patient entirely at rest for the first part of the period of treatment, and restrict activities later till the process of infection is definitely subsiding.

Keep up the patient's morale, and that of the family as well. Better explain to them early that the patient will need observation over a period of months or even years.

But nothing is quite so well worth while. Results can be obtained and the neck left free from scars.



In considering differential diagnosis, Hodgkin's disease is commonly first found in the neck. This usually occurs in young adults; the glands are hard, firm and discrete; there is no adherence to the skin or the deeper tissues, at least in the early stages. Again, the trained, sensitive fingers are most diagnostic.

Lymphosarcoma occurs just often enough to make us suspicious of any chronic lymphadenitis in an adult. Lymphatic leukemia may give its first sign by swelling of the nodes in the neck, and may be in young or old. A swollen lymph node may be the first complaint in a carcinoma hidden away in the inside of the mouth.

Get adequate blood examinations, or excise a gland for pathological examination, if there is any doubt at all. This may save many future explanations, if the clinical course happens to be unhappy.

Actinomycosis is unusual, but must be kept in mind in the differential diagnosis of those non-healing, draining deeper lesions. Make direct smears and see if you can find the characteristic filaments.

Infection in the salivary glands is most commonly that of parotitis in epidemic form, or mumps, which is usually handled by the pediatrician. It is a self-limited disease, and the only difficulties are in the complications.

Septic parotitis is usually found in those individuals who cannot or will not take liquids by mouth, perhaps most often in those postoperative gastric or peritoneal cases where fluids must be given in other channels for the first few days. The best treatment is prophylaxis, by the use of chewing gum. Encourage the patient to use his jaws and stimulate the flow of saliva, even if you do not yet feed him by mouth.

Septic parotitis is not the fatal or dangerous complication mentioned in some of the textbooks. I have observed a number of cases regress spontaneously, or heal kindly after local incision and drainage.

Another site of infection about the neck is inflammation in the cysts and sinuses from branchial cleft remains. These account for a few that cannot be explained other-

wise. These branchial cleft structures occur in a diagonal line, downward and inward, from the ear to the sternum. They burrow deep, and if excision is attempted, rather than mere incision of an acute abscess, be ready to follow the tract deep, often between the internal and external carotid arteries, to the deeper layers of the cervical fascia around the pharynx.

Infection untreated in these cysts may give a mass the size of a hen's egg, which on rupture will give a chronically discharging sinus.

Injection of methylene blue is an old and simple trick but one well worth while. It is much easier and simpler to inject the tract first and follow along the line of color, whatever your personal skill in fine dissection may be.

Then the ever recurring differential diagnosis of syphilis must be made in infections of the neck. If the primary lesion is about the lips or face, the regional lymph nodes are in the neck, and will early show signs of enlargement. The primary lesion may be well hidden on the inside of the mouth, or throat, so look closely if the history is subacute and the glands hard. Again this is a bit unusual, but the active practicing surgeon will see one often enough to keep his diagnostic eye open.

#### SUMMARY

1. Use gentle manipulation and small incisions in treating boils or furuncles of the neck.

2. In carbuncles, if conservative methods do not quickly bring results, use wide crucial incisions with undercutting of the flaps.

3. In chronic lymphadenitis, unless you use wide dissection, adopt a regime of increased general nutrition, and use aspiration or small incisions if suppuration occurs.

4. Watch for the unusual but rapidly developing Ludwig's angina with its poor prognosis.

5. In all neck lesions, make a careful differential diagnosis and use biopsy frequently.

# FRACTURES OF NOSE

JOSEPH D. KELLY, M.D., F.A.C.S.

Assistant Surgeon, Manhattan Eye, Ear and Throat Hospital; Surgeon, Fordham Hospital

NEW YORK

THE object of this paper is to discuss in a general way fractures of the nose as seen by the general practitioner, or general surgeon and usually caused by blows, falls, or other less severe traumas—not those severe injuries to the facial bones resulting from automobile, aeroplane, or other bad accidents. Such injuries are in a class by themselves, and should be handled by some surgeon trained and proficient in this type of work. In view of the number of such accidents today it is surprising to know how few general hospitals have an associate competent and able enough to take care of these cases properly. Many of these patients are eventually sent to the plastic surgeons, though they might have been saved this second operation.

In speaking of fractures of the nose we cannot speak of the fractured nasal bones alone but must take into consideration injuries to the other bones which enter into the formation of the nasal arch. It is possible to have a fracture of the nasal bones alone such as might occur if the patient were hit forcibly on the dorsum of the nose with a pointed instrument, thereby causing a central separation of the bones or a lateral depression of one bone. However, in most cases of fractured nose, as referred to by the majority of the profession and many of the laity, there is generally an involvement of the nasal process of the superior maxilla, the lacrimal bone, or the nasal spine of the frontal bone, or some injury to the septal cartilage. It is the involvement of the lacrimal bone and the nasal spine of the frontal bone which causes the severe ecchymosis sometimes seen in injuries involving the nasal arch.

In adults the nasal bones are thick and narrow at their upper extremities, and thin, broad and much exposed to injury at their

lower portion. Hence, blows at the base of the nose are more likely to cause a fracture of the nasal spine of the frontal bone, the lacrimal bone or some portion of the anterior ethmoid, whereas blows on the lower two-thirds of the nasal arch usually involve the nasal bones and the nasal processes of the superior maxilla.

Injuries of the nose in children are very important and should not be regarded as trivial. They are important because we are dealing with immature growing bone and cartilage with a highly sensitive periosteum and perichondrium. The nasal bones are not very large in children and as a result are fairly well protected from falls. The septal cartilage takes the greater part of the force of the fall and hence may be bent, broken or torn from its attachment to the nasal spine of the superior maxilla. When this occurs, a hemorrhage may lift the perichondrium and mucous membranes from their attachment to the cartilage and thus seriously interfere with the nutrition of that cartilage. Such a condition is a very serious one and unless taken care of properly and promptly may result in a septal abscess with a partial or complete absorption of the septal cartilage and consequently a deformed nose. These cases are usually brought to the neighborhood doctor with a history that the child was playing tag with the other children and slipped and fell on the curb, the step of a porch or other object which might cause the force of the fall to be delivered on the tip of the nose or in the region of the nasal spine of the maxilla. The child complains that he cannot breathe through his nose and examination by the general practitioner shows a swelling behind the columella-nasi blocking off both nostrils. The skin and mucous membranes covering the anterior por-

tions of the septum are ballooned in such a manner as to press against the inner surfaces of the alae of the nostrils. There

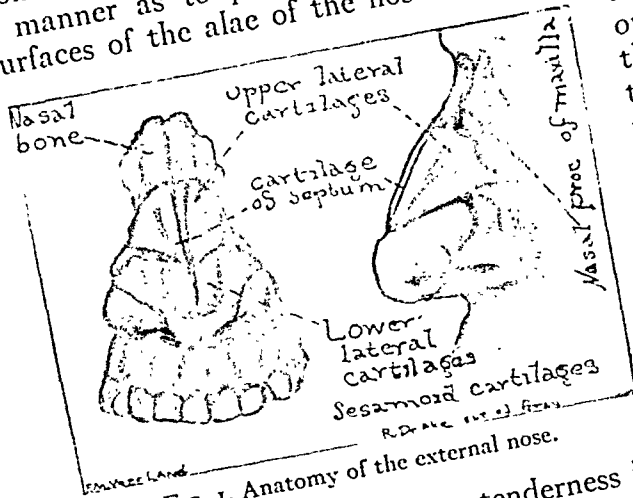


FIG. 1. Anatomy of the external nose.

may be no pain, redness, or tenderness in this area when the case is first seen. However, if nothing is done for the relief of the hematoma these symptoms will appear

available to have him in for consultation. If this is not possible, the next best thing to do is to administer an anesthetic, make an incision at the mucocutaneous margin on both sides of the septum and evacuate the hematoma, being careful not to do further injuries to the tissues. Then, by the use of a Gruenwald forceps or other type of biting instrument, cut out a strip of mucous membrane about  $\frac{1}{4}$  inch in width and  $\frac{3}{8}$  inch long on each side of the septum in order to establish free drainage of the hematoma. From this point the manner of treatment is in the hands of the surgeon taking care of the case. One thing that should be borne in mind however, is the fact that packing of any sort should not be used. There is no set formula for taking care of these cases after this operation, but our best success has been obtained by using hot saline irrigations in the anterior part

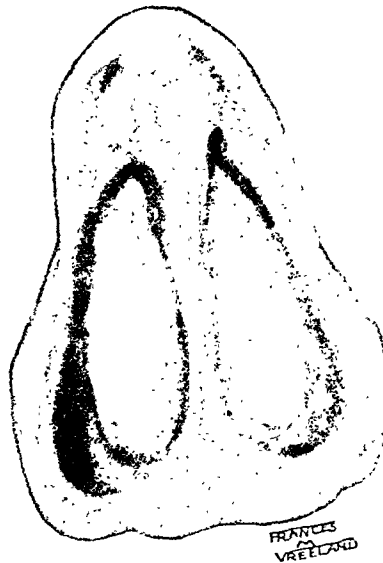


FIG. 2. Septal abscess.

within four or five days. This reaction is the result of the infection of the hematoma through a rupture of the septal mucous membranes occurring at the time of the fall and resulting in a septal abscess.

The general practitioner would be wise to send these cases to the hospital when first seen, and if there is a competent rhinologist

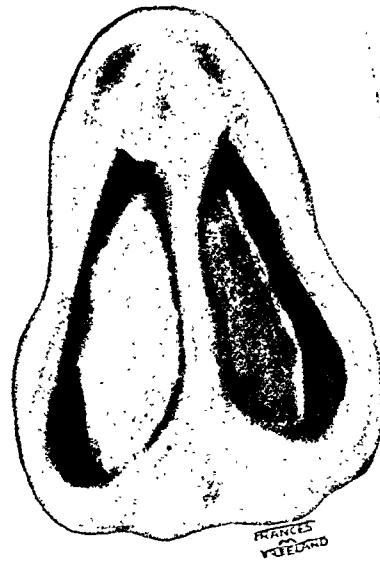


FIG. 3. Right angle fracture.

of the nose, every three or four hours until the swelling subsides and the tissues are well on their way to resolution. Irrigations may be stopped as soon as the child can breathe through his nose.

Children falling on their nose very often fracture the septal cartilage without the formation of the hematoma, but causing an

almost right angle deviation of the septum in its anterior third. This sometimes results in a marked twisting of the tip of the nose to one side with a complete obstruction of one nostril and a compensatory obstruction of the other nostril. There may also occur a fracture of the cartilage along its horizontal diameter in such a way as to form a severe ridge or spur in the septal cartilage itself with a lateral deviation of the tip to one side.

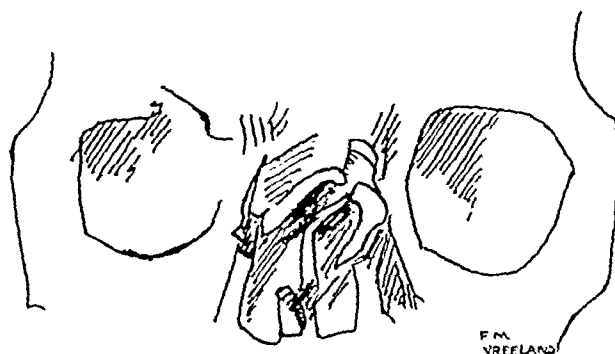
Much can be done for these cases if they are seen by the rhinologist within a reasonable length of time after the injury, but if two or three days elapse before the child is seen in consultation, it may be too late to do anything, or to form an opinion as to the amount of damage done. We often consider it the better part of discretion to wait until some of the swelling subsides, before making an examination or instituting any form of treatment requiring manipulation of the tissues. At this stage, these cases are problems enough for the competent rhinologist and no general surgeon should feel that he knows enough about treating such conditions to interfere.

Fractures of the nasal bones and the associated bone of the face in children are usually of the green-stick variety, unless the injury be a severe one of the compound comminuted type. The fact that the majority are of the green-stick variety make them more difficult to handle. It is practically impossible to show some of these fractures with the x-ray picture and the swelling of the soft tissues is often such, as to make it difficult to determine accurately, the extent of the injury when the case is first seen. After the soft tissue swelling subsides, there may be a noticeable swelling on the surface of the nasal bone, or the nasal process, as a result of the reaction of the periosteum to trauma. The bone or bones on the injured side of the nose become thicker and more resistant and have a tendency to influence the development of the bones on the uninjured side. This may cause a lateral deviation of the bridge of the nose which secondarily effects the

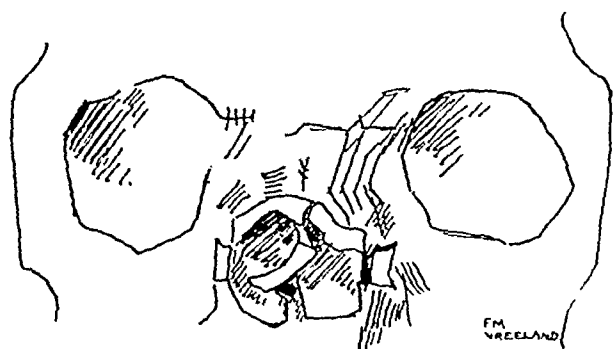
position and growth of the septal cartilage. In children, it is impossible to tell how much influence the fall or other injury will



AFTER KAZANJIAN  
GROUP I



AFTER KAZANJIAN  
GROUP II



AFTER KAZANJIAN  
GROUP III

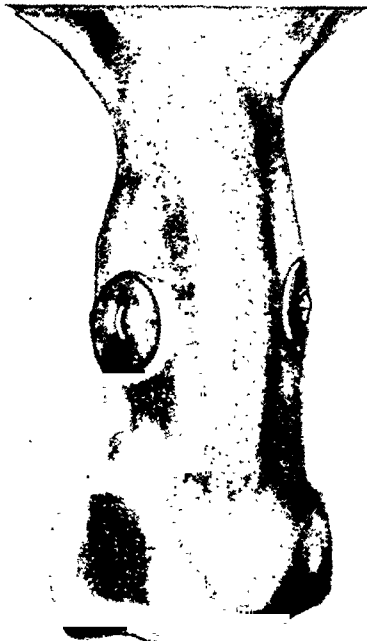
FIG. 4.

have on the future growth of the nose. Hence, they should be kept under observa-

tion and treatment instituted if and when it is deemed advisable.

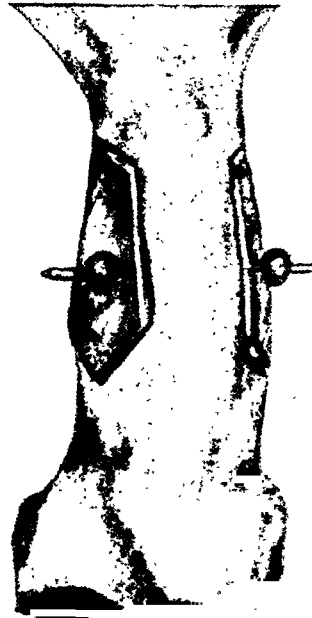
Care and judgment must be used in the

the arch of the nose and I believe that Kazanjian of Boston has illustrated this very well in an article<sup>1</sup> before the Academy



FRANCIS  
VREELAND

FIG. 5. The Gordon B. New method.



FRANCIS  
VREELAND

FIG. 6. The Joseph D. Kelly method.

surgical interference of these cases, and one cannot state at what particular age interference is justified. If the condition is such that it interferes with the health and happiness of the child, surgical interference is justified at any age. However, the operator must bear in mind the fact that he is dealing with young growing tissue and be careful not to destroy any more than is necessary and to have a wholesome respect for the centers of growth and ossification (Figs. 2 and 3).

In fractures of the nose in adults we do not have to take into consideration the many problems that confront us with children. It is mostly a question of determining the type of fracture with which we have to deal and instituting the proper mechanical measures for a realignment of the bones involved and holding them in position long enough so that they may become fixed in the normal process of repair.

The types of fractures in adults vary with the direction in which the force strikes

of Ophthalmology and Otolaryngology in 1933, in which he divided the fractures into three groups (Fig. 4).

Force delivered from above downward on the side of the nose usually causes a depressed fracture of the nasal bone and the upper and anterior portion of the nasal process and possibly the lacrimal bone on that side. Force delivered laterally may cause a fracture and displacement of the nasal bones and the upper part of the nasal processes. Force delivered from above along the whole upper surface of the nasal bones may cause a separation and fracture of these bones together with the nasal processes, thereby giving the nasal arch a more flattened appearance. Sometime the nasal bones may be comminuted with the maxillary borders overlapping the nasal processes of the maxilla. The bony septum is often involved together with the cartilaginous septum which may be twisted or

<sup>1</sup> KAZANJIAN, V. H. *Tr. Am. Acad. Ophth. and Otolaryngol.*, 1933, pp. 275-308.

bent or completely separated from the nasal bone.

Fractures of the nose are not difficult to

men agree that it should not be delayed more than ten days at the outside.

For anesthesia in the reduction of a

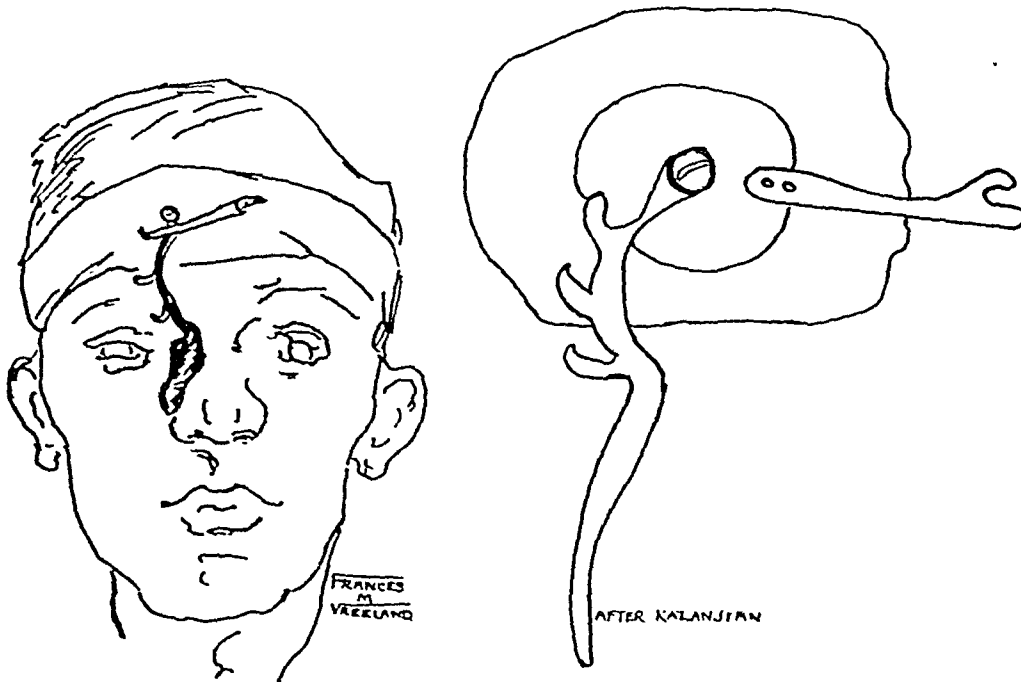


FIG. 7. Kazanjian method; rubber band used for pressure.

diagnose as there is usually a history of injury and the symptoms are very obvious. The soft parts show considerable swelling immediately following the injury and the contour of the nose is disturbed, depending upon the degree of the severity of the trauma and the displacement of the fractured parts. Very often we can get crepitus and there will be tenderness on pressure over the site of the fracture. There may be a hemorrhage from one or both sides of the nose with difficulty in breathing caused by the swelling of the mucous membranes. When the case is not seen until some time after the injury, a roentgenogram will often show the fracture.

Treatment of the case varies according to the degree of the injury. If there are any lacerations of the skin, these should be thoroughly cleansed, and all foreign bodies removed, and the edges carefully approximated with fine suture material and with small needles, such as those used by the eye surgeon. Time may be allowed for the inflammation to subside before the reduction of the fracture is undertaken, but most

simple fracture it may only be necessary to pack the nose with gauze and cotton saturated with a mixture of equal parts of 10 per cent cocaine and 1:1000 adrenalin. The pledgets of gauze or cotton should be placed in the nasal fossa in the location of the fractured area and allowed to remain in position for fifteen or twenty minutes. However, if the patient is very nervous and excitable, nitrous oxide and oxygen anesthetic may be used. Then with the aid of a Ballenger elevator which is placed along the upper part of the septum in the area of the fracture, the nasal bones are lifted from their depressed position to a proper alignment with the nasal process. If the fracture is of the second degree and the displacement involves the bones on both sides of the nose, it may be necessary to alternate the elevator from one side to the other, using the thumb as a fulcrum and forcing the nasal bones to the median line, at the same time elevating them into position. If there is a fracture or dislocation of the septal cartilage at the chondro-osseous junction, in addition to the bony fracture,

it may be necessary to pack either one side or the other of the nose with vaseline gauze in order to keep the cartilage in position. In depressed fractures involving the whole arch of the nose, with considerable comminution of the nasal bone as shown in type III, it may be necessary to devise or use some one of the mechanical devices constructed for the purpose of keeping the fragments in position long enough for them to be united. The use of any splint or any device which does not elevate the fragments should not be considered. New<sup>2</sup> of the Mayo Clinic uses a suture of non-absorbable material, such as horse hair or deknatel, which is placed through the lower area of the fragments, and he so attaches a lead plate or button to each side of the nose that it lifts the fragments into position. We have made use of this method, substituting the ordinary copper wire with lead shot for the suture. It may be necessary to use some arrangement attached about the head, but this is very seldom required except when the injury involves other bones than those forming the nasal arch. Kazanjian has devised a very ingenious method of handling fractures causing a lateral displacement of the nasal arch, or of the bones on one side of the nose (Figs. 5, 6 and 7).

<sup>2</sup> NEW, G. B. *Surg. Cl. N. Am.*, 15: 1241-1250 (Oct.) 1935.

#### SUMMARY

Simple fractures of the nasal bones if corrected early should not show any evidence of deformity. Occasionally, however, it may be necessary to refracture the nasal bones in order to reduce the displacement and hold them in position by an external splint. Moderately severe fractures, complicated by displacement of the septum, may require an operation for submucous resection if they are seen two weeks or more following injury. In comminuted fractures of the nasal arch it is very necessary that the cases be handled carefully, because if the injury is a severe one and proper reduction of the fracture is not effected, and the fragments are not held in position long enough, they will undoubtedly come to a secondary operation requiring a transplant of cartilage, or cartilage and bone, for the relief of the deformity.

In closing I would like to say that in order to understand the fractures and displacement that may occur in the nasal bones it is necessary to keep in mind the anatomy of the external nose, the position of the nasal bones, and their relationship to the nasal processes of the superior maxillary bones and also the position and shape of the upper and lower lateral cartilages and the septal cartilage.



# FRACTURES OF MANDIBLE AND MAXILLA

FRED SQUIER DUNN, M.D., D.D.S., F.A.C.S.

Oral Surgeon, Lenox Hill Hospital; Assistant Oral Surgeon, New York Post-Graduate Medical School and Hospital, and Babies Hospital

NEW YORK

**F**RACTURES of the upper and lower jaws present a different problem than fractures of any other bones in the body for we are dealing here not only with the broken continuity of a bone and its attendant problems, but with the restoration of the masticatory apparatus which requires the interdigitation of thirty-two or less teeth with the exactitude of a precision instrument. The reestablishment of the normal relationship between the teeth in the upper jaw and those of the lower jaw is the ultimate and final goal of treatment, and upon this more than any other factor should the results of the case be judged. To enumerate and classify the causes of these fractures would be to waste time on a subject of little more than academic interest. With a bone exposed as the mandible is, jutting out from the skull like a peninsula, differing from the bones of the extremities in that it can move in but one small arc to protect itself from impending trauma, and also that from the beginning of man it has received more than its just share of attention at the hands of the belligerently inclined; a bone whose structure is inherently weakened by the implantation of teeth in the same manner that knots reduce the strength of a hickory plank, it is a wonder, not that it is frequently broken but that it is not commonly broken. Let it suffice to say that the fist, the steering wheel and the automobile dash board are largely responsible for this injury. Furthermore, practically all fractures of the maxilla and mandible are compounded. The maxilla is almost always compounded into the oral cavity, the maxillary sinus or the nasal cavity. In the mandible, those fractures of the condyle, the coronoid process and the upper part

of the ascending ramus, which are deeply imbedded in soft tissue, are practically the only ones which are not compounded; fractures of the body invariably rupture the tightly drawn and inelastic mucous membrane covering or produce a break along the root of some tooth. Fortunately, for the human race, these two bones have built up a certain degree of localized immunity to infection which is of inestimable aid, but which I fear has lulled many men into a position of false security and induced them to take liberties that they would not take with bones in other regions of the body. Unless handled with sound, surgical principles, infection is all too likely to occur.

The most practical and certain method of accomplishing the desired result is the early reduction and immobilization of the fracture in such a way that the teeth are directly placed in their proper occlusion. This necessitates the use of some adequate method of wiring, which will hold the jaws firmly together. As this naturally restricts the airways and makes the emission of vomitus difficult, it sometimes has to be delayed until the general condition of the patient warrants it, as in such cases as shock and injuries to the head, chest and abdomen. It should be instituted as soon as possible, however, as delay makes reduction difficult, invites infection, and is largely responsible for those cases of delayed union and non-union which are the bane of all fracture work. Because of post-anesthetic vomiting, general anesthetics are rarely used. The few times when there is resort to them are in nervously unstable people and small children, and then the wiring should not be carried to the point where the jaws are fastened together until



all chance of vomiting has passed. In general, these cases need rarely be hospitalized and lend themselves excellently to office practice and local anesthesia.

As the restoration of occlusion normal to the individual is the aim of treatment, so an abnormality of occlusion is the outstanding sign in the diagnosis of fractures of either jaw. Other signs and symptoms are drooling, inability to bite hard, a false point of motion, displacement of parts with deformity, localized tenderness, indirect tenderness, crepitus, ecchymosis and in the upper jaw, occasionally emphysema. The roentgenogram is, of course, of great help in the lower jaw but frequently of little value in the upper, as the maxilla is so often driven upward and backward and impacted upon the adjacent bones that a line of separation is not presented. A careful clinical examination will usually establish a diagnosis. All parts of the mandible should be radiographed before treatment is instituted as these frequently reveal fractures of the condyle or some other region which would have been masked clinically by the more evident fracture. They should be carefully studied for comminuted fragments and teeth in line of fracture. With few exceptions, teeth in the line of the fracture should be removed and certainly all fractured teeth in the line of fracture, as they tend to promote infection and delay union. Comminuted fragments should be retained wherever possible. Because of the greater vascularity and thin cortical structure of the upper jaw most fragments which still retain their periosteal attachment will live and form a part of the healing process. Fragments in the lower jaw, with its relatively avascular structure, however, are much more likely to die and the same liberties cannot be taken in leaving them in situ that can be taken in the upper jaw.

The method of immobilization which I use almost exclusively and which is in no sense original with me, can be best understood by a study of the illustrations. After reduction has been accomplished to the best of one's ability an 18 gauge German silver

wire is cut so as to extend from the posterior border of the last tooth in the upper jaw on the right side, to the posterior border of the last tooth on the left side and is then so bent as to touch, when completely free of tension, the outside surface of every tooth in the upper jaw. This German silver band wire is then firmly fastened to the upper jaw by passing 22 gauge brass wires around each individual tooth and the band wire. The same thing is done in the lower jaw. At this point all we have is two band or arch wires firmly fastened to each jaw, but with the jaws open and free of each other (Fig. 1). If a general anesthetic is being used the procedure should stop at this point until all chances of postanesthetic vomiting has passed. A 26 gauge brass wire is then doubled and passed around the upper and lower band wires with the jaws in apposition and brought taut. Usually three of these intermaxillary wires are used on each side and usually in the molar and bicuspid regions, because these teeth are more powerful and better able to stand the strain than the incisor teeth (Fig. 2); but every case presents its own problem, and the available useful teeth are necessarily the ones to be utilized regardless of which ones they are.

This method has several distinct advantages over any other. In the first place, one can see the result being obtained which is not possible with the use of cast metal splints. In the second place, it distributes the strain of immobilization equally to all the available teeth and not to just one or two which is the case with other methods of wiring. In the third place, it is not necessary to obtain immediate and complete reduction as the intermaxillary wires may be placed in any direction and by using one jaw or the other as a fulcrum the fragments of the opposite jaw may be moved in any desired position, by the application of continuous, firm, but gentle tension exerted over a period of time (Fig. 3). This is particularly useful in those fractures in which the maxilla is so badly impacted upon the adjacent bones of the

skull that even with direct traction it cannot be dislodged, and in those fractures of either jaw in which there has been a delay in reduction, and healing has already started in malposition. In the fourth place, in cases of emergency or in periodic examinations, the jaws may be opened quickly and easily by merely cutting the intermaxillary wires and may be replaced in a few minutes without wrecking the whole system of wiring.

Every effort should be exerted to prevent infection of compound wounds no matter how slight they are. Adequate drainage should be established and maintained until the wound is thoroughly covered with granulation tissue. It is much easier to prevent than to cure an osteomyelitis, and besides, when infection does take place at the site of fracture, union is markedly delayed. It is a mistaken conception that the lower jaw is not easily infected, and it is not difficult to understand why this is, when one realizes that the patient is actually spitting into the wound every second of the day. No other bone in the body could withstand such a bacterial onslaught.

When the mucous membrane is sufficiently torn in upper jaw fractures to produce communication between the mouth and the antral cavity, the mucous membrane should be immediately sutured so as to close the mouth off from the antrum. If this is not done and the antrum is exposed to the invasion of mouth bacteria for any length of time, the whole procedure will very likely be complicated by an antral infection. It may be necessary to drain the wound to prevent infection of the bony fragments, but the drain should not be extended into the antral cavity.

Fractures of the condyle are rarely compounded because of the protective mass of soft tissue in which the condyle is situated. Reduction of these fractures is practically impossible unless one uses the open method, which procedure, however, is quite unnecessary. If the jaws are wired together with the teeth in their proper occlusion

union will be obtained. Anatomically, as shown by the roentgenogram, the result is poor, but that is a matter of inconsequen-



FIG. 1. Shows the band or arch wire adjusted to the tooth and fastened to each individual tooth.

tial importance because functionally the patient will get an excellent result.

There are some fractures at the angle of the jaw which present a special problem in maintaining reduction because of the constant pull of the muscles of mastication, chiefly the masseter and temporal muscles. The black mark in Figure 2 indicates the direction of such a fracture. In these cases, the line of fracture is such that it permits the posterior fragment to be drawn upward away from the anterior fragment. There are various methods of dealing with this problem. The simplest is to place some suitable material such as gutta percha or modelling compound against the upper teeth so that the posterior fragment will be held downward and in contact with the anterior fragment. This is not always possible, and when it is not, it is necessary to resort to some form of surgical wiring, such as boring holes in the posterior and anterior fragments and passing wires through them in such a manner as to hold

the posterior fragment down, or making an incision just behind the angle of the jaw through the skin and boring a hole through

dealing with it, but one simple method which in most cases is quite efficacious is to remove the intermaxillary wires and for



FIG. 2. Shows the intermaxillary wires running vertically with the teeth in occlusion.



FIG. 3. Shows the intermaxillary wires placed at an angle, using the upper jaw as a fulcrum and drawing the left side of the lower jaw forward.

the posterior border of the ascending ramus through which a silver wire is passed and fastened to an elastic band and adhesive at the base of the head. The first method has the distinct disadvantage of implanting a foreign body in a contaminated area which will almost certainly become infected.

In edentulous cases, the fracture is reduced and maintained in position by means of a head bandage. I have found that all types of gauze bandages soon become loose and to overcome this tendency elastic traction with adhesive has been found most useful.

As I have previously noted, non-union or delayed union most commonly follows cases in which infection has set in or in which there has been a definite delay in immobilization. This is hardly the place to enumerate the other possible causes of this complication. There are several methods of

two or three days permit the patient to gently open and close its mouth but not to masticate food. The jaws are then re-wired from one to two weeks when the procedure may be repeated as many times as is necessary. The gentle irritation produced in the line of fracture will frequently stimulate the deposition of calcium salts sufficiently to produce bony union. Another simple and quite satisfactory method is to bore small holes in the proximal surfaces of the fragments and keep the jaws immobilized. This will frequently stimulate bony union. If these relatively simple methods fail I believe that resort to a bone graft should be made but this is only possible after the wounds have completely healed. Cases of prolonged non-union requiring immobilization for several months introduce another serious factor in that the

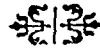
supporting structures of the teeth suffer from atrophy of disuse. Some of the teeth may become extremely loose and eventually be lost. I have never seen diet or medication influence the course of these cases. However, I do believe that it is sound judgment to keep such patients out in the sun and put them on a high vitamin regime. Certainly no harm can result from it and it might do some good. The problem of feeding these fracture patients is relatively simple. They are placed on a liquid diet of high caloric content, and, in spite of the fact that they may have a full complement of teeth, they are always able to suck enough through their teeth to easily provide their normal nourishment.

In a paper as general as this it is impossible to speak in any detail of the various phases of this work, however, I should like to emphasize again that the end-result is

to be judged by the restoration of the function of the masticatory apparatus.

#### SUMMARY

Fractures of the upper and lower jaws present certain problems peculiar to themselves in lieu of the fact that they are in close apposition to the accessory nasal sinuses and are a large part of the delicately balanced masticatory apparatus. The restoration of this apparatus is the chief aim of treatment. Fractures should be reduced and immobilized as quickly as possible and adequate drainage established to prevent infection. A type of immobilization which maintains the teeth of the opposing jaws in their proper relation and one which distributes the strain to as many teeth as possible is desirable. Local anesthesia is better adapted to this work than general.



# FACIAL SCARS

CLAIRE L. STRAITH, M.D.

Chief, Division of Plastic Surgery, Harper Hospital; Plastic Surgeon, Michigan Children's Hospital

DETROIT, MICH.

THE proper management of facial injuries is a surgical subject of great moment. With increasing numbers of facial lacerations following in the wake of ever increasing numbers of motor car accidents, skillful attendance by general practitioner and surgeon alike is required more frequently now than ever before. The immediate, so-called "emergency" care of these victims is but one phase of this subject. The management of the late sequels, namely unsightly scars, constitutes an equally important chapter. Their devastating effects upon the happiness, mental health and even livelihood of the disfigured victims must not be underestimated. The psychic trauma may cause more suffering than the physical lesion itself. Children are particularly affected; brooding over their defects has induced serious complexes and detrimental personality changes which blight their entire span of life. Sensitive adults, too, have become social recluses or business failures. The extent to which such psychological catastrophes have contributed to present social problems, particularly unemployment and unemployability, is difficult to determine, though undoubtedly great. The problem of facial scars thus presents many important aspects.

A first consideration in the management of the acute laceration should be the prevention of unsightly scar formation. Hasty, ill-considered "emergency treatment" is almost inexcusable. When proper facilities for painstaking repair are not available at the time, it is better to apply merely a sterile dressing and await a better opportunity. Immediate closure of facial wounds without preliminary cleansing and without careful trimming of the jagged edges cannot be too vigorously condemned.

Equally blameworthy is the use of large skin clips or coarse catgut and silkworm sutures. Such closures practically always leave heavily pigmented scars with conspicuous stitch marks that are almost impossible to eliminate at a later date. The essentials, then, for proper closure of recent wounds of the face are careful cleansing of the laceration, removal of foreign bodies, trimming of skin edges, and the use of fine suture materials threaded on fine needles. Skin tension which leads to wound separation and the formation of wide scars should be eliminated by the use of buried tension sutures. These principles are of paramount importance in the prevention of unsightly scars following facial lacerations.

Surgical measures to improve the appearance of unsightly facial scars demand an equal regard for surgical principles lest trying to better we "mar what's well." A well equipped office operating room similar to that maintained in the modern hospital, is the first essential. Before attempting treatment, however, it is important that the patient should be told frankly what result may be expected. The lay press, unfortunately, has fostered the belief that all scars can be excised so as to "leave no trace." This notion, if held by the patient, must first of all be dispelled. Circumstances permitting, however, the patient can be assured of a cosmetic result infinitely superior to the old scar if well considered plastic procedures are properly carried out. It is important to recall that scars at right angles to the lines of Langer, due to stretching, will of necessity be more conspicuous than those which parallel these lines. The latter variety may eventually leave only a fine hair line, scarcely visible scar. Scars in young persons will remain red much longer than those of persons of middle and

advanced age. These and other important facts must be borne in mind since they determine the prognosis to an important degree.

production of a minimal scar depends to a great extent upon the skill with which this phase of the operation is executed. Interrupted sutures of any type are prone to

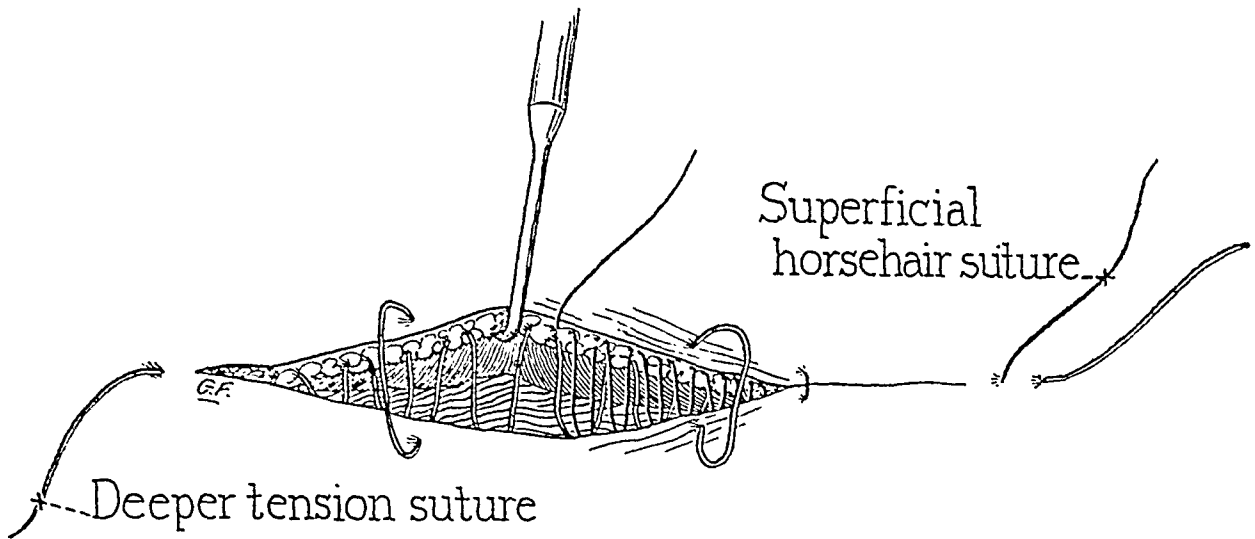


FIG. 1. Double subcuticular stitch.

The following resume outlines the usual procedures followed by the author:

*Preparation.*

1. Thorough cleansing of the entire face with green soap and water wash, followed by alcohol;

2. Infiltration around the scar with a 1 per cent solution of novocaine containing ten drops of adrenalin per ounce.

*Operation.* The scar is first completely excised, after which the surrounding skin is undercut to permit approximation of the skin edges. When scars directly overlie bone, a subcutaneous fat pad is provided by drawing in the adipose tissue from each side of the wound. This prevents adhesion to the bone and consequent scar depression. Skin tension is next relieved by the use of buried interrupted sutures placed in the subcutaneous fascia. The author prefers dermal and small white silk sutures for this purpose. Although some of these sutures are often extruded later, they nevertheless maintain wound approximation sufficiently long to prevent spreading and consequent wide scar formation. Buried sutures are used freely in scars crossing Langer's lines to counteract the pull of these elastic fibers.

Skin closure, the final step in the operation, is a most important one. The eventual

leave stitch marks. For this reason the author advises the use of subcuticular sutures. A  $\frac{5}{8}$  inch curved eye needle threaded with medium dermal suture is best. The needle is inserted into the skin  $\frac{1}{4}$  inch below the lower angle of the incision and brought into the end of the wound. The stitch then passes subcuticularly throughout the entire length of the wound, picking up tissue every  $\frac{1}{4}$  inch on each side at the base of the dermis and at exactly the same distance from the surface on each side. In a long wound, the suture is brought out to the surface on one side and inserted again on the opposite side making an external loop every 1 to  $1\frac{1}{2}$  inches. This loop can later be cut to permit removal of the suture in sections. A second subcuticular stitch of horsehair, threaded on a fine semicurved eye needle, is next inserted at  $\frac{1}{8}$  inch intervals just beneath the skin surface. This stitch should be brought to the surface at  $\frac{3}{4}$  to 1 inch intervals to facilitate subsequent removal. These two subcuticular sutures bring about more perfect skin approximation and leave less residual scar than any other method known to the author (Fig. 1).

Slight wound separations may be approximated by a stitch of fine horsehair

threaded on a eye needle. Stitch marks are avoided by tying the knot with only the first two twists of the surgeon's knot. The second knot is omitted because it tends to increase wound tension and cause the stitch to cut the skin, thereby increasing scar formation.

Drainage is usually recommended in the primary closure of deep wounds. In secondary operations for the removal of scars, drainage is seldom necessary if complete hemostasis has been obtained.

Heavy dressings should not be used. One thickness of bandage material placed over the wound and held in place by means of collodion, placed *around*, not *on* the wound, usually suffices.

Bed rest is required for twenty-four hours. An ice bag is placed over the dressing and kept there more or less continuously for two or three days if necessary.

Removal of sutures is begun at the end of forty-eight hours. At this time, interrupted or subcuticular horse hair sutures are removed if they have loosened sufficiently. The subcuticular dermal stitch may be left in place for eight to ten days while firm union is taking place. This suture leaves no scar. Hence it may be retained for a longer period to minimize wound spreading.

In spite of all precautions, keloid formation will develop in persons with this

diathesis. Postoperative x-ray therapy will usually improve or minimize this condition.

Trichloroacetic acid applied on fine toothpick applicators is useful for smoothing down small overlapping skin edges. This may be repeated several times, if necessary, until the best possible cosmetic result is obtained. Cinder marks may also be removed in this manner by repeated applications at two or three week intervals.

#### SUMMARY

1. Prevention of conspicuous scar formation should be the chief aim in the management of acute facial lacerations. Adherence to certain principles will prevent or minimize such scars; thorough wound cleansing; avoidance of wound tension by the use of buried tension sutures; the use of fine suture materials and needles. Heavy suture materials, such as skin clips, catgut, silk-worm gut, etc., have no place in facial surgery.

2. Secondary operations to remove unsightly facial scars also require finer methods of suturing and wound treatment.

3. The psychological benefit which may be derived from the removal of very conspicuous scar formation must not be overlooked. Persons handicapped by such deformities may be restored to society and business by well considered, carefully planned surgical procedures.



# CONCEALMENT OF SCARS

JOSEPH A. TAMERIN, M.D.

Adjunct Plastic Surgeon, Harlem Hospital, New York City, and Jewish Hospital, Brooklyn

NEW YORK

OF the various factors that render scars visible, the color, erythematous in the early stages, is one of the most important. Though the technique of suturing might have been painstaking, the healing by primary intention, neverthe-



FIG. 1. The result of multiple Davis grafts to the head for traumatic avulsion of the scalp.

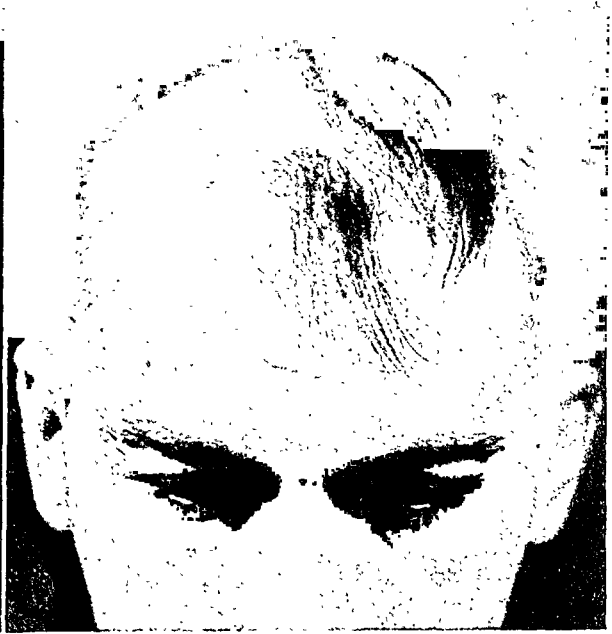


FIG. 2. Scars covered with covermark.



FIG. 3. The resultant scar rendered practically inconspicuous with covermark.



less, the reddish color of the scar and its shiny surface texture will vitiate some of the satisfaction of the patient with the re-

will be grateful for an inexpensive, harmless means of concealing the scars. This means is provided in covermark, which is a colored



FIG. 4. A case of multiple more or less discreet hemangiomata (port wine stain). These areas were excised.

sult. Particularly is this true, obviously, with scars on the exposed surfaces, and especially the face. In time, of course, most scars will fade, but until they do, patients



FIG. 5. The scars covered with covermark.

cream base, available in a number of shades to match the complexion. The cream is applied to the scar and smoothed on the skin. The accompanying photographs show the results obtained by the application.



## STYES

EDWARD J. BASSEN, M.D.

Assistant Surgeon New York Eye and Ear Infirmary; Assistant Attending Ophthalmologist, French Hospital

NEW YORK CITY

THE hordeolum, or sty as it is more commonly known, causes subjective and objective symptoms out of all proportion to its seriousness. The result of a suppurating inflammation of a solitary Zeis or Meibomian gland of the lid, it begins with an inflammatory edema of the affected lid, which at times spreads markedly to involve the bulbar conjunctiva, or more alarming to the sufferer down onto the face. Shortly there develops a point of localized tenderness and induration, which marks the location of the involved gland, followed in two or three days by evidence of suppuration, a yellow spot appearing at this site, which later breaks down and discharges pus. Should the Zeis gland be involved, as most usually happens, this point of suppuration occurs at the margin of the lid on the skin surface and in an infection of the Meibomian gland on the tarsal surface or at the mouth of the gland on the intermarginal space.

An occasional solitary sty being analogous to the occasional acne pustule from which most individuals at one time or another suffer, represents, bacteriologically and pathologically, an infection by the staphylococcus of a sebaceous gland. A single sty, then, is of no serious consequence apart from the passing discomfort and need of local treatment.

However, two groups of individuals tend to suffer from recurrent crops of styes and for these the physical and, in women, the mental anguish is often considerable. The first group includes those sufferers from blepharitis whose red, crusted and scaly lids furnish an excellent media for growth of the staphylococci. The second group consists of children and adults with normal lids, who because of poverty and poor

living conditions, fail to obtain sufficient fresh air, sunlight and adequate food; or those adults who because of overwork, lack of sleep and fresh air become "run down" and anemic and whose lowered resistance renders them susceptible to an infection to which they would otherwise not succumb.

The treatment of the sty itself consists in the application of hot moist compresses fifteen to twenty minutes three or more times daily until the point of suppuration appears, at which time an incision is made with a sharp pointed knife, and the pus evacuated. It is usually advisable to continue the compresses for a few days after this, because in this way, the return of the lid to its normal appearance is hastened. It would seem that eventually the practitioner would learn that the application of yellow oxide of mercury is not of any value in the treatment of a sty and usually aggravates the condition, but it is still the universal home remedy and many a physician is guilty of encouraging this form of medication.

In the cases of recurrent styes, in addition to the local treatment, the blepharitis if the underlying cause must be treated, and if the patient's poor health be the causative factor, it is most important that means be undertaken to remedy the situation with more rest, fresh air, etc., and treatment of anemias or other pathological conditions. Occasionally all other attempts at prevention failing, autogenous vaccines may possibly be of help. While many oculists stress the importance of wearing glasses which correct refractive and muscle errors as a means of preventing styes, it is my experience that this form of therapy is not of much value or importance.

# CINDERS AND SPLINTERS

HOWARD L. UPDEGRAFF, M.D., F.A.C.S.

Director of Department of Plastic and Reconstructive Surgery, Cedars of Lebanon Hospital, Hollywood; Chief of Plastic Surgery Service, Orthopaedic Hospital, Los Angeles

HOLLYWOOD, CALIF.

MANY transient patients demanding emergency minor surgery have become permanent through the ability of the doctor to give quick relief without additional pain. Every office should be equipped with instruments specially designed for the removal of foreign substances such as cinders and splinters. Nothing is more disconcerting and can ruin a day so completely as to spend an hour trying to remove a cinder or find a splinter, with ill suited tools and poor anesthesia, and finally give up saying, "Better go to the hospital and take a general anesthetic in the morning."

The preparation of the patient has a good deal to do with the success of the original procedure. For instance, a cinder in the eye will be much more amenable to removal if a drop of 4 per cent cocain or one of the local anesthetics, butyn or metacain, is placed on the cornea before any detailed inspection is undertaken. A hand with a splinter will be a much easier problem if soaked in hot soapy water for ten or fifteen minutes, while the instruments are boiling. A comfortable table with the patient lying under a good light during the surgery is a necessity.

Eyes are so important that one should know whether or not they are competent to remove a deeply embedded foreign body and handle the possible complications. If complications do develop and it is necessary to call in an eye specialist, no one is going to thank you for your desire to take a try at it. However, there is no harm in inspecting the eye, after preliminary anesthesia, to see if a foreign object is present and if undiscernable, to instill a drop of 1 per cent aqueous mercurochrome to show up possible scratches on the cornea. An alert

secretary once in taking a careful history of an eye case, where I could find nothing, disclosed the possibility of exposure to steel splintering and an indicated x-ray examination saved the day for me by disclosing a good sized piece of steel in the eye ball.

The increase of automobile accidents, even with the growing tendency of all-steel bodies, still presents us with a variety of foreign substances. The most common is that of a graphite-like substance from oil drippings and exhaust pipes, which is fast forming a complete covering on all of our streets. This graphite-like material is the dark blue substance which appears under the scar surface about the time the patient is debating whether to make the final payment on your bill. It is usually deposited deep in the wound in small particles and in the rush to close the wound to stop bleeding, it is encapsulated and appears at the surface later.

Receiving hospitals ordinarily do not have time to adequately take care of cases presenting lacerations with possible inclusion of foreign material. The reason is that the average case will do a great deal better if no attempt is made at a complete and immediate repair, all arguments regarding the wound being sterile for the first six hours notwithstanding. Attention to acute hemorrhage, followed by a moderate cleansing of the wound with liquid soap and water, or peroxide followed with alcohol or mild iodine, will insure moderate asepsis. A moist dressing, with sufficient pressure to control too brisk oozing, kept on until a convenient time for a more leisurely and efficient repair, will give a cleaner and dryer wound in which to work.

This plan allows the patient relief, both mental and physical, and an opportunity to arrange his time and affairs to suit the best interests of all concerned. If roentgenograms are indicated for localization they may be taken during this interval. Incidentally it takes an excellent radiologist to find a non-metallic foreign object, be it cinder or splinter, and he should be given plenty of time for his search. Films, utilizing two to four positions, will materially simplify a long dissection. If antitetanic serum is indicated, it may be given underneath the abdominal skin after first freezing the area with ethyl chloride sprayed through an opening made in a double thickness of adhesive. This gives anesthesia at the point desired and protects the surrounding skin.

Not every splinter need be removed. Men who are wood workers and who have hard calloused hands will show numerous splinters which have been embedded for weeks with no irritation. These work to the surface by themselves.

It is amazing the large size of splinters which may be embedded in soft tissue without a great deal of distortion or swelling. The subcutaneous hardness is ascribed to induration, while subsequent efforts at removal may bring out various amounts of debris for days. The best way of looking for a splinter is to work from the point of insertion rather than trying to short cut to the area where you think it should be. A strong concentrated light for transillumination is oftentimes of value. Splinters under the nails are tremendously painful, and anesthesia will best be attained by a circular injection near the joint, rather than to add insult to injury by attempting to inject under the nail.

I learned from a dentist some years ago to use a "carpule" syringe for local anesthesia. Aside from its general efficacy in surgery, I find that by keeping the novocain carpules and needles submerged in an antiseptic solution, I have an emergency

set-up, par excellence. The use of a 27 gauge needle with a long flat bevel materially aids induction. Some surgeons refuse to use any syringe medication that is not carpule contained, thus insuring against possible accident in solution preparation.

A surgical nurse taught me that a No. 11 Bard Parker blade is a good instrument for foreign object removal. I have found that either a Ralk's or a Watter's splinter forceps and an eye spud with the three interchangeable spuds of stainless steel are necessary for the instrument set-up. A "Berger loupe" or a good headlight and a magnifying glass are indispensable aids. Harold Gifford, in my school days, demonstrated the necessity of immobilizing an eye after a foreign object removal. There is a simplified eye shield on the market, made for either eye, that does away with adhesive strips and simplifies removal by the patient for home irrigations and instillation of a mild ophthalmic ointment as indicated.

#### CONCLUSIONS

It is extremely important that all foreign matter be removed from skin wounds, especially on the face. As a plastic surgeon I find a large percentage of cases coming to me for the repair of seemingly trivial scars which could have been avoided by a little extra care at the time of the injury. These defects oftentimes reach such importance in the patient's mind as to become a major obsession. These people are from both sexes and of all walks and occupations of life. They all have the same story, "The doctor said it would not amount to anything and to forget about it." They are willing to go to a great deal of trouble and expense in their desire to look like their old selves. The prevention of such problems lies in the preparedness of the doctor. We must remember that as in business, the small order often brings the big order.

"For the Colonel's lady and Judy O'Grady Both get cinders and splinters under their skin."

# FOREIGN BODIES IN EXTERNAL AUDITORY CANAL\*

HARRY ROSENWASSER, M.D.

Adjunct Otologist, Mt. Sinai Hospital

NEW YORK CITY

A SURVEY of the records of The Mount Sinai Hospital reveals that foreign bodies in the external auditory canal occur most commonly in young female children between two and one-half and seven years of age, the right ear being involved more frequently than the left. The experiences of Keen,<sup>1</sup> however, are not in accord with ours; of 51 cases of foreign body in his series, omitting the cotton wool variety, there were 23 in the right ear, 27 in the left and one not stated. Keen advanced the explanation that five or six year old children when playing, are really ambidextrous.

Previous unsuccessful attempts at removal were the rule in our patients. This is in agreement with the experiences of Politzer<sup>2</sup> who stated that hardly 10 per cent of the cases which come to the specialist had not undergone some manipulation. Some of the foreign bodies removed by us included beans, peas, a piece of porcelain crockery, glass beads of varied sizes and shapes, a tooth, a button, small pieces of graphite from a lead pencil, pieces of onion and cotton. The commonest foreign body encountered in adults, according to Asherson,<sup>3</sup> is cotton wool which generally is inserted by the patient and forgotten. Other authors have reported finding fruit seeds, pebbles, glass, shot, insects, larva, coffee beans, slate, etc. Foreign bodies in the external auditory canal may be divided into two groups, those which cause few, if any symptoms and those which cause severe symptoms.

1. *Foreign Bodies Which Cause Minimal Symptoms.* Occasionally during the course of an otolaryngologic examination, a foreign body may be discovered in the ear. For example, a child was referred to the Out

Patient Department for an opinion as to the advisability of tonsillectomy. On looking into the external auditory canal, one saw a round red object which moved when the head was rotated into various positions. It was ascertained upon questioning the parent, that the child frequently played with a red bead necklace. On syringing the external auditory canal with warm water a small bead was washed out.

Another patient was seen in the clinic complaining of foul smelling discharge from the right ear of many years duration. The canal wall close to the tympanum was covered with granulations. There was considerable purulent discharge in the external auditory canal and the tympanic membrane was not visible. Upon touching the granulations with a probe, the dirty grayish area which was thought to be the inner tympanic wall covered by granulations, moved. With a bayonet forceps, the grayish mass was gently loosened and removed. To our surprise, it was a piece of cotton about  $\frac{1}{4}$  inch thick, encrusted with calcium salts. The drum was found intact. Within a few days, the granulomata on the canal wall disappeared and "the middle ear discharge" of many years duration ceased.

Poltzer<sup>2</sup> reported an instance in which a piece of slate 3 cm. long was present in the external auditory canal for fifty years with no complaints other than deafness. The patient was seventy years old at the time of the removal of the slate and complained only of poor hearing. Zaufal<sup>4</sup> and Lucae<sup>5</sup> reported removing cherry stones from the external auditory canal of asymptomatic patients after forty and forty-two years respectively. Wells<sup>6</sup> reported a case of deafness of thirty-three years duration resulting from placing a pea into the

\* From the Otologic Service of Dr. I. Friesner, The Mount Sinai Hospital, N. Y. C., N. Y.

external auditory canal which was cured after removal of the foreign body.

2. *Foreign Bodies Which Cause Symptoms.* As was stated before, some foreign bodies cause few symptoms whereas others may cause severe symptoms such as extreme nervousness, headache, reflex trigeminal and vagal manifestations. In 1909 Dimitriadis<sup>7</sup> published a monograph containing a complete and excellent historical bibliography of the literature on foreign bodies. Abdulla<sup>8</sup> reported a case of intractible hiccough which resisted even large doses of morphine, but which was relieved after removing an impacted plug of cotton wool from the external auditory canal. It was formerly a common practice for inhabitants of India to place cotton wool scented with "Itter" into the auditory canal. In 1646 Fabricus v. Hildanus<sup>9</sup> reported curing a patient suffering from epileptiform attacks and cough of eight years duration, by removing a glass bead from the external canal.

Within the past ten years there have been numerous and unusual reports of foreign bodies in the external auditory canal. Foster<sup>10</sup> reported a bizarre case in which a facial paralysis cleared up after removing a tick  $\frac{3}{16}$  inch long which had embedded itself in the floor of the external auditory canal. Irrigations removed considerable debris and pus, and the author then could see what proved to be a blood engorged tick which he removed with a forceps. Chavanne<sup>11</sup> described a patient with headache and vertigo, in whom the symptoms ceased promptly after the removal of foreign body from the external auditory canal where it had been pressing against the drum. Kennedy<sup>12</sup> described a case of persistent cough of thirty-six years duration which was alleviated following the removal of a rice grain from the ear canal. Hilton<sup>13</sup> reported an instance in which a boy thrust an eraser from the end of a lead pencil into his external auditory canal. The eraser could not be removed in toto. Ultimately the retained eraser caused an erosion of the drum and annulus, neces-

sitating radical mastoidectomy before a cure was effected. Many instances have been reported of flies in the external auditory canal causing severe symptoms. Richards<sup>14</sup> cautions against trying to remove flies with a forceps even under direct vision advising that they will be difficult to grasp and that there is danger of doing damage with the forceps. The insect should be killed first by instilling a few drops of a mixture of chloroform and oil into the external auditory canal and then removed by irrigation. One of the most unusual foreign bodies on record was reported by Seshachalam<sup>15</sup> who removed a living scorpion 1 inch long from the external auditory canal. This patient was awakened at 4 A.M. with severe pain in the ear and five hours later in a hospital the scorpion was removed by syringing. Chaliar and Rousset<sup>16</sup> reported a tragic case in which a three year old child pushed a small stone into his external auditory canal. Attempts at removal failed. Some time later the child was brought to a hospital with obvious tetanus which, despite tetanus antitoxin, ultimately proved fatal. Large numbers of tetanus bacilli were found in the ear discharge.

Much of the trouble associated with foreign bodies in the external auditory canal arises from resort to forcible, ill advised attempts at removal usually by well intentioned parents or occasionally by general practitioners. The difficulty in removing foreign bodies, according to Asherson,<sup>3</sup> increases rapidly in direct proportion to the number of previous unsuccessful attempts at removal.

Certain foreign bodies when moistened, swell to many times their original size. This characteristic must be borne in mind, because forcible irrigations of these foreign bodies will result in swelling and further impaction. Repeated instillations of absolute alcohol will often cause drying and shrinkage of this type of foreign body, making subsequent removal easier. Small hygroscopic objects when dry, may readily enter the external auditory canal. After an interval of time they may swell and com-

pletely fill the external canal, frequently with resultant severe symptoms.

Brief mention will be made of a few of the cases of aural foreign body observed during the past three years at the Mount Sinai Hospital and Out-patient Department in order to point out certain important features in the treatment. One case will be discussed in detail, because it demonstrates some of the complications that may develop.

#### CASE REPORTS

CASE I. I. C., female, aged three years had a foreign body (bean) in her *right* external auditory canal. Previous attempts at removal without anesthesia were unsuccessful. Admitted to the hospital and under general anesthesia, bean was removed with a blunt hook. The drum was found to be intact. Ammoniated mercury ointment 5 per cent was applied locally.

COMMENT. It is best not to irrigate beans and like vegetable matter. They are likely to swell and become impacted. It is safer to remove them with instruments or probes under direct vision.

CASE II. M. P., female, aged seven years, had a foreign body (piece of porcelain crockery) in the right external auditory canal which was found to be deeply imbedded. There was considerable edema and narrowing which resulted from previous unsuccessful attempts at removal without anesthesia, prior to admission to the hospital. Under nitrous-oxide oxygen anesthesia, the foreign body was grasped with forceps and gently removed. Ammoniated mercury ointment 5 per cent was applied to the canal.

COMMENT. Sharp, heavy, irregularly shaped foreign bodies of this type at times may not be removed by syringing. It is best to attempt removal with forceps, watching the edges of the foreign body so that the canal is not traumatized.

CASE III. M. N., female, aged three years, had a foreign body (glass bead) in the right external auditory canal. Previous attempts at removal were unsuccessful. Under general anesthesia the bead was easily washed out by syringing the external auditory canal. Drum was found to be intact. Ammoniated mercury ointment 5 per cent was applied locally to the canal.

COMMENT. Small beads with smooth surfaces may be difficult to grasp with instruments. Frequently, however, they are easy to remove by forcible syringing.

CASE IV. S. L., male, aged seven years, had a foreign body (tooth) in the right external auditory canal. Efforts at removal by parents were unsuccessful. Under general anesthesia the impacted tooth was grasped with a forceps and removed. The drum was found to be intact. Ammoniated mercury ointment 5 per cent was applied locally to the canal.

COMMENT. Under direct vision this type of foreign body is easy to grasp with forceps and remove.

CASE V. T. R., male laborer, aged forty-five years, suddenly experienced pain in his right ear while working on a road construction job. On examination, a small piece of gravel was seen embedded in the outer layer of the drum. All landmarks were visible. Under local anesthesia, the foreign body was gently removed with a blunt curette. Follow-up a few days later showed complete resolution about the site of the foreign body.

COMMENT. If irrigations fail, we found that using a blunt curette under direct vision, was most successful in dislodging and removing the foreign body.

CASE VI. E. G., female, aged five years, had a foreign body (bead) in the right external auditory canal of eighteen hours duration. Many unsuccessful attempts at removal made without anesthesia before admission to the hospital. The foreign body was impacted and there was considerable narrowing at the isthmus. Under general anesthesia syringing proved unsuccessful. A small hook was inserted into the hole in the bead and the foreign body thus extracted. Ammoniated mercury ointment 5 per cent was applied locally. The drum was reddened but within a few days the drum was completely resolved and the patient was discharged well.

COMMENT. This type of case is potentially dangerous. As is well known, the cartilaginous canal is somewhat elastic whereas the osseous portion of the canal is rigid. Frequently it is easy to remove a foreign body when it is in the distensible portion of the canal, whereas it may be very difficult or impossible to remove it if it becomes impacted in the bony portion of the canal. Fortunately in this instance the small hook engaged the hole in the impacted bead thus making removal possible. Whenever

hooks are used in intrameatal manipulations one should always use direct vision and have excellent illumination.

CASE VII. C. B., female, aged three years, had a foreign body (bead) in the right external auditory canal of ten hours duration. Previous attempts at removal were unsuccessful. The foreign body appeared impacted at a point just beyond the junction of the cartilaginous and bony canal walls. The auricle and external auditory canal were inflamed. Bloody discharge oozed from the canal wall about the bead. In the Emergency Ward, without anesthesia, attempts were made to remove the foreign body by irrigation without success. Under nitrous-oxide oxygen anesthesia, attempts were made using a soft silver probe, small hooks, etc., to dislodge or turn the bead and thus make it possible to slide a blunt hook between it and the drum and extract it. These maneuvers also failed. There was such marked swelling at the isthmus, that removal without great trauma appeared improbable.

Incident to the manipulations, the cartilaginous canal was traumatized, the resultant bleeding obscuring vision. Because of the danger of forcing the impacted bead into the tympanic cavity further efforts were discontinued. At this stage, to quote Asherson,<sup>1</sup> we were in that unenviable position of trying to remove a cork from a bottle without being able to use a corkscrew. A wet dressing was applied to the external auditory canal and auricle, to expedite subsidence of some of the swelling. It is of historic interest to mention at this point that Paulus Aegineta<sup>17</sup> in the sixteenth century made a postauricular crescentic incision for the removal of an aural foreign body which could not be removed by the available intrameatal methods.

Our patient developed fever, nystagmus to the left and pain, and therefore we dared not wait as long as we ordinarily would have for the edema in the canal to subside. The following day, a postauricular incision was made about  $\frac{1}{2}$  inch behind the auricle, the skin and periosteum reflected. The cartilaginous canal was separated from the bony canal. Already granulations were present on the bony canal wall about the bead, which was tightly wedged against the canal wall and drum. The foreign body was turned with a Barth curette and removed by irrigation. The drum appeared intact and quite edematous.

The bead was a large flat white one resembling a button, with an imitation ruby

cemented into its center. This finding explained the impression we had that we were dealing with a red bead. Complete hemostases was obtained and the postauricular wound was then closed. The external auditory canal was tightly packed to avoid atresia of the canal, frequently a distressing sequel to this procedure. According to Richards particular care must be taken to replace the canal lining in order to avoid this complication.

Two days later the patient developed fever, angina, a strawberry tongue and a punctate rash over the body. The diagnosis of scarlet fever was made and the patient quarantined. Labyrinthine symptoms, nausea, vomiting, nystagmus to the left and falling towards the right side became manifest at this time. The tight packing was considered responsible for the irritative labyrinthine symptoms, and although we were loathe to remove the packing for fear of developing an atresia, it was deemed the more conservative of the two alternatives. The temperature was 103°F. and signs of an acute suppurative otitis media appeared on the right side. This ear discharged spontaneously. The external auditory canal became narrowed and inflamed. No landmarks were visible and granulations filled the fundus of the auditory canal. The postauricular wound did not heal and there was an enormous amount of thick pus from the middle ear. The rash disappeared. At this time no cause for the fever, leucocytosis and pain could be found other than the ear status. Two weeks after the removal of the bead, facial erysipelas developed. This was treated with ultra-violet rays.

Because of the profuse thick middle ear discharge of two weeks duration, the fever, the mastoid tenderness and positive roentgenologic findings, a simple mastoidectomy was performed under avertin anesthesia. Pus under pressure was found immediately on removing the mastoid cortex. The mastoid bone was the seat of widespread disease. Necrotic granulations had formed between the cartilaginous and bony canal since the removal of the foreign body, which were removed. The mastoidectomy was completed and the external auditory canal firmly packed.

Forty-eight hours after operation there was a recurrence of the facial erysipelas which was again treated with ultra-violet rays. The profuse discharge from the middle ear and mastoid wound gradually diminished. Twelve days later the patient was referred to our Out-patient Department ear clinic for dressings. The



follow-up report six months later showed "that the mastoid cavity was healed, and the middle ear discharge scant." The mother stated that, "the ear began to discharge again only after the child had a cold."

COMMENT. This three year old child was in the hospital for almost seven weeks. She had three general anesthetics, one postauricular incision for the removal of the foreign body, a simple mastoidectomy, scarlet fever and two bouts of erysipelas. This sequence of events strikingly illustrates some of the serious complications one may encounter in the treatment of aural foreign bodies.

#### DISCUSSION

Complications can often be avoided if certain basic principles are borne in mind. Of great importance according to Richards,<sup>14</sup> Keen,<sup>1</sup> Asherson,<sup>3</sup> Myers<sup>18</sup> and others is the necessity of good reflected light in carrying out any manipulations. Because foreign bodies occur frequently in young children in whom one cannot rely on complete cooperation, it is advisable to administer a general anesthetic before attempting removal. A struggling, insecurely held child is apt to move at an inopportune moment and cause trauma to the external auditory canal with resultant bleeding and swelling, thus making a potentially simple procedure quite difficult. On the other hand, one must remember that an anesthetized child cannot indicate when the surgeon may be causing trauma possibly of a serious nature.

After the patient is anesthetized forcible irrigations should always be tried first, provided, of course, the tympanic membrane is intact and that the foreign body is not hygroscopic. The nozzle of a good strong ear syringe covered with a soft rubber tip should be inserted into the external auditory canal close to the foreign body, directing the stream of warm water between the foreign body and the canal wall. The external auditory meatus should be straightened out by pulling the auricle upward and occasionally it is helpful if the mouth is agape. In most cases this procedure will suffice to dislodge and remove the foreign body. Zaufal, quoted by Dimitri-

adis,<sup>7</sup> was able to remove 92 of 109 foreign bodies from the ear by syringing, and these statistics are similar to those of Schwartz and other authors.

Should this method fail, we must consider the other methods at our disposal. It is manifest, from the variety of foreign body one may encounter, that no inflexible rules can be dogmatically formulated, as to how to proceed. We do feel that intrameatal manipulation with instruments should be performed by the specialist rather than by general practitioners. The anatomic configuration of the external canal varies in different individuals. The size, shape and physical characteristics of the foreign body, the length of time it has been in the external auditory canal, the presence or absence of swelling, bleeding, otorrhea or stricture at the isthmus, are all factors which indicate which is the method of choice to follow. Whether to operate or to apply wet dressings and await the subsidence of the acute inflammation, can, in the last analysis only be decided by the otologist observing the patient at the time.

Foreign bodies which swell, such as beans, peas or seeds, should be treated promptly by repeated instillations of absolute alcohol into the external auditory canal, to cause shrinkage of the hygroscopic foreign body. When this has been accomplished, one can frequently dislodge the hitherto fixed foreign body by inserting a bent silver probe between it and the canal wall. We must heed the caution of Richards who advised against using force from below upward when an object is deep in the canal, since it is possible to push the object into the middle ear or attic. Occasionally it may be advantageous to break this type of foreign body and remove it piecemeal with a forceps. Care must be exercised to remove all of the foreign body.

We do not like to use sharp hooks because of the danger of injuring the external auditory canal. When their use is unavoidable, the sharp point of the hook should be seen all the time thus lessening the likelihood of trauma. A tooth, irregular glass objects or pieces of crockery can frequently

be grasped with a small-toothed forceps and removed by gentle manipulation under direct vision. On the other hand when smooth hard foreign bodies, like pearl beads, are grasped with toothed forceps they tend to slip away and are often forced deeper into the external auditory canal. If undue force is used the foreign body which was originally situated close to the external auditory meatus, may be thrust deep into the osseous canal, or even into the tympanum. Trauma of this extent can cause dislocation of the ossicles, hemorrhage, facial paralysis or injury to the larynx. It is amazing how readily a foreign body will in certain positions pass into the external auditory canal and how difficult, after it changes its position, it becomes to remove it until it is manipulated back into the original position in which it entered.

#### CONCLUSIONS

The factors of paramount importance in the removal of foreign bodies in the external auditory canal in children, are that all manipulations be performed under a general anesthesia. Good illumination, preferably reflected light, is a necessity. No attempt at removal should be made, to quote Richards, until prepared to cope with any situation which may arise. Hygroscopic foreign bodies require removal at the earliest moment but should be treated with absolute alcohol before any efforts at removal are undertaken. The method of choice in the removal of non-hygroscopic foreign bodies, is that of forceful syringing with warm water or solution of boric acid, provided there is no perforation in the drum.

Syringing having been tried repeatedly under general anesthesia, or being contra-indicated, the physical properties of the foreign body will then determine whether one uses blunt curettes, blunt or sharp hooks, silver probes, forceps or whatever instruments are available. After removal of the foreign body, ammoniated mercury ointment 5 per cent should be applied liberally to the walls of the external auditory canal.

In those instances in which it becomes necessary to employ a postauricular incision in order to remove an impacted foreign body which is causing severe symptoms, one must pack the external auditory canal firmly postoperatively to avoid atresia. If the middle ear is discharging it is safer to risk an atresia by not packing than it is to pack and court an otitic complication.

#### REFERENCES

1. KEEN, J. A. Foreign bodies in the ear and nose. *Jour. Laryng. and Otol.*, 45: 333-343 (May) 1930.
2. POLITZER, A. Diseases of the Ear. Lea & Febiger, Philadelphia, 1926.
3. ASHERSON, N. Foreign bodies in the external auditory canal. *Clin. Jour.*, 61: 110-113 (March) 1932.
4. ZAUHAL, E. Quoted by Dimitriadis. *Über Fremdkörper im Menschlichen Ohre*. Athens, P. D. Sakillarios, 1909, p. 139, 195.
5. LUCAS, A. *Fremdkörper des Ohres*. Eulenberg's Real Enzyklopädie der Gesamten Heilk., Urban and Schwartzberg, 5: 398-404, Wien and Leipzig, 1881.
6. WELLS, J. L. Foreign body removed from ear after 33 years. *Brit. Med. Jour.*, 2: 637-638 (Oct. 8) 1927.
7. DIMITRIADIS, D. S. *Über Fremdkörper im Menschlichen Ohre*. Athens, P. D. Sakillarios, 1909.
8. ABDULLA, M. Foreign body as a cause of persistent hiccup. *Indian Med. Gaz.*, 65: 445-446 (Aug.) 1930.
9. FABRICIUS v. HILDANUS. Quoted by Politzer, *Geschichte der Ohrenheilk.* Stuttgart, F. Enke, 1: 153-154, 1913.
10. FOSTER, B. A tick in the auditory meatus. *Med. Jour. Australia*, 18: 15-16 (Jan. 3) 1931.
11. CHAVANNE, L. Vertige et Céphalée par Corps Étranger de l'oreille y séjournant depuis vingt ans. *Oto-rhino laryngo internat.*, 19: 69 (Feb.) 1935.
12. KENNEDY, W. P. Foreign body in ear for 36 years. *Brit. Med. Jour.*, 1: 14 (June 7) 1928.
13. HILTON, G. E. M. Foreign body in the external auditory canal. *Can. Med. Assn. Jour.*, 33: 308 (Sept.) 1935.
14. RICHARDS, G. L. Foreign bodies in the external auditory canal. *Am. Jour. Surg.*, 6: 514-516 (April) 1929.
15. SESHACHALAM, T. Unusual foreign body (scorpion) in external auditory canal. *Indian Med. Gaz.*, 62: 145 (March) 1927.
16. CHALIER, J. and ROUSSET, J. Foreign body in the external auditory canal causing tetanus in a child 3 years old. *Lyon Med.*, 141: 675 (June 10) 1928.
17. BRIAN, R. Translation of *Chirurgie de Paul D'Egine*. Paris, v. Masson, 1855. Chap. 24, pp. 143-145.
18. MYERS, G. L. Removal of foreign bodies from the aural canal. *Jour. Kansas St. Med. Soc.*, 34: 351 (Sept.) 1933.

# INCISIONS OF DRUM MEMBRANE IN OTITIS MEDIA\*

JOSEPH G. DRUSS, M.D.

Adjunct Otologist and Assistant Otopathologist, Mt. Sinai Hospital; Instructor in Otopathology, Columbia University Post-Graduate Courses

NEW YORK

**I**NCISION of the drum membrane, commonly known as myringotomy or paracentesis, is one of the earliest operations practiced by the otologist. Judging from the satisfactory results obtained from this procedure its value cannot be overestimated. In the course of time, with our increase in knowledge of the clinical and pathologic conditions of the tympanum, mastoid, and their adnexa, the indications for myringotomy have naturally undergone changes. While in the majority of conditions of the middle ear there is agreement among otologists as to the indications for myringotomy, opinions may differ as to the precise time of carrying out this procedure. It is agreed that a knowledge of the surgical anatomy of the tympanic cavity as well as the pathology, physical signs and symptoms of otitic infections are prerequisite and most essential to the otologic surgeon.

## ANATOMY

It is not the purpose of this paper to enter into a discussion of the minute anatomy of the tympanum, only those features which have any bearing upon the operation will be considered. It must be remembered that the tympanic membrane is a transparent concave oval disc, about 0.1 mm. in thickness. It forms an oblique angle of about 55 degrees with the horizontal plane, so that its upper border is closer to the auricle than is the lower border. An outstanding landmark of the tympanic membrane is the hammer handle, the lower margin of which is situated at the umbo. The latter is the site of the greatest concavity. Situated at the upper anterior part of the drum is the

short process of the malleus which jets out rather prominently. From this structure there are two striae, one running upward and forward and the other upward and backward to the margin which inclose the flaccid part of the drum known as Shrapnell's membrane. The remainder of the drum is tense and is known as the pars tensor. From the umbo a cone of light extends downward and forward to the margin.

It must also be borne in mind that the distance between the tympanic membrane and the inner tympanic wall is relatively small, measuring only 2 to 4 mm.

Histologically, the tense portion of the drum is comprised of three layers; (1) an outer cutaneous layer, (2) a middle fibrous layer consisting of outer radiating and inner circular fibres, and (3) an inner mucous membrane layer.

In infants the tympanic membrane is practically of the same size as in the adult.

## PATHOLOGY OF ACUTE MIDDLE EAR SUPPURATION

As is well known, suppurations of the tympanum are most frequently secondary to infections of the nasopharynx, extension taking place by way of the eustachean tube. In the early stages there is swelling of the mucosa lining the tympanum with engorgement of the vessels. This is soon followed by an extravasation of exudate. The exudate at first is serous or serosanguinous, but later assumes a purulent character. These changes in the tympanum usually make themselves manifest on otoscopic examination by progressive changes in the drum. As a result of the accumulation of the purulent exudate, the tympanic mem-

\* From the Otolgic Service of Dr. Friesner of the Mount Sinai Hospital.

brane bulges out until rupture finally takes place. It must be borne in mind that this ballooning out cannot always be ascribed to the mechanical pressure of the purulent exudate within the tympanum; it may be secondary to a marked thickening associated with inflammatory changes within the drum itself. This, in all probability, is an important factor in the production of localized areas of fulness so frequently seen, instead of the diffuse bulging of the entire drum.

While the appearance of the drum on otoscopic examination is usually an index as to the nature of the pathologic process within the tympanum, at times, owing to either a markedly thickened membrane or to previous scarring, the two conditions do not correspond. Hence a severe inflammatory process may exist in the tympanum without corresponding changes in the drum membrane.

There is strong evidence in favor of the view that suppuration in the tympanum is not always secondary to infection in the nasopharynx or eustachean tube. This is particularly true in the acute infectious diseases as measles, scarlet fever, etc. Here, in all probability, the mucous membrane of the entire upper respiratory tract including the tympanic cavity is simultaneously involved through the blood stream. The otitis produced in this manner may show no characteristic clinical or pathologic features and the indications for myringotomy here differ in no way from those in the usual infections.

In a consideration of the pathology of middle ear suppuration it must be emphasized that the tympanum, aditus and antrum are in reality one cavity. With practically every infection of the tympanum there is simultaneously or shortly thereafter a more or less corresponding condition in the aditus and antrum. One must even go a step farther and state that with every suppurative process in the tympanum and antrum there is usually a concomitant involvement of the mucosa lining the pneumatic spaces of the mastoid

and of the petrosa. This involvement consists of thickening of the mucosa with engorgement of the vessels, which in the majority of instances subsides. While the significance of these pathologic changes in the temporal bone are quite apparent they must not be construed by themselves as indicative for early myringotomy.

#### PHYSICAL SIGNS AND SYMPTOMS

Signs and symptoms of acute middle ear suppuration vary with the individual case. As a rule there is first seen a congestion of the vessels of the drum membrane. This is soon followed by redness, thickening and some fulness. By this time the light reflex is obliterated. With the increase of fulness the other markings such as the hammer handle, the folds of Shrapnell's membrane and finally the short process gradually disappear. The red discoloration may assume a yellowish tint, particularly at the site of greatest tension.

In the course of development of these signs, the patient complains of fulness in the ear, pain varying in intensity, usually sharp or sticking, increased by motion of the head, and diminution of hearing. Tenderness over the mastoid is not infrequent at an early stage of the infection. The temperature may be only slightly elevated. In children, however, an elevation to 104 or 105 degrees F. is not unusual. Here also the other symptoms are more pronounced so that vomiting, general debility, and even convulsions may be present.

#### INDICATIONS

No hard and fast rules can be set down regarding the exact indications for myringotomy. Each case must be evaluated on its own merits. Naturally the physical signs and symptoms constitute most important criteria in deciding upon the time of operation. In addition, however, factors such as the type and virulence of the organism, method of extension, the age, the general condition and temperament of the patient must be taken into consideration. In the

presence of a bulging drum with all the landmarks obliterated, with pain, tenderness over the mastoid, and impaired hearing, there can be no question as to the advisability of a paracentesis. An ear with findings such as these seldom goes on to resolution without discharge, either spontaneous or by incision. All of these classical symptoms need not be present, however; severe pain or marked postauricular tenderness associated with rapidly progressive changes in the drum may be considered sufficient evidence to warrant incision. A principle which we have followed on the otologic service of The Mount Sinai Hospital is that a myringotomy is performed when on otoscopic examination all landmarks of the drum including the short process have disappeared. This structure is usually the last to be obliterated. A drum presenting such a picture even in the absence of other physical signs or symptoms warrants incision. The desirability of applying this principle is demonstrated by the fact that in the vast majority of instances with such findings frank purulent exudate is obtained.

As is well known, in some epidemics of upper respiratory infections or of the acute infectious diseases the invading organism shows a particular affinity for the middle ear. One soon learns by experience the peculiarities of the particular infectious process. Here, when rapid progress of the infection in the middle ear is observed, one is justified in doing a myringotomy somewhat earlier than usual, particularly if the patient cannot be under very close observation.

Again, in the elderly patient with diabetes or with other debilitating disease, where it is well established that infections spread with great facility, a myringotomy at a time somewhat earlier than that commonly agreed upon is indicated. In the same category may be placed the suspected pneumococcus type 3 infections of the ear where the degree of impaired hearing is usually out of proportion to the other physical signs. Here, the infection, although

of a slow and insidious nature, progresses with destructive tendencies and often involves the intracranial structures.

In isolated instances where the temperature remains elevated or where there is evidence of continued sepsis and when the cause of these cannot be ascribed by the internist or pediatrician to any condition other than to the ear, one is justified in incising the tympanic membrane. This should be done even though the appearance of the drum and the otitic symptoms are not quite those which would warrant it under ordinary circumstances.

Of particular interest is the type of otitic infection which is not infrequently observed at the outset of a lobar pneumonia, especially in children. This is characterized by a reddish pink drum which goes on to diffuse thickening but with very slight if any bulging. The landmarks disappear very slowly. The child complains of pain in the ear, and the condition is most often noted by the pediatrician in the routine examination. At the height of infection, the short process is barely visible through the thickened membrane. It has been our experience that this type of infection usually resolves spontaneously without rupture and does not require myringotomy. In these cases there are the usual symptoms of pneumonia. On occasions the correct diagnosis of lobar pneumonia has been suggested on otoscopic examination by the appearance of the tympanic membrane even before frank signs in the chest have become demonstrable.

For a time there was a difference of opinion among pediatricians and otologists with regard to indications for myringotomy, and even mastoidectomy in the severe gastrointestinal intoxications in infants. This was due to the fact that the basis upon which the indications were established rested, on the one hand, chiefly on the general physical condition of the patient, and on the other hand chiefly on the otitic condition. The tendency now is, and I believe rightfully so, to be guided more and more by the otoscopic findings

but always bearing in mind the general condition of the patient.

In the so-called influenzal or "grippe" otitis the outstanding feature is the presence of hemorrhagic blebs on the drum and in the external canal. These blebs vary in size and are usually associated with considerable pain. They may appear very early in the otitis and very frequently rupture before the landmarks on the drum have fully disappeared. A serosanguinous discharge from rupture of the blebs may be misconstrued by the patient as evidence of spontaneous rupture of the tympanic membrane. The presence of blebs should not influence the indications for myringotomy one way or the other. They usually require no special treatment. However, on occasions, incision of these alone affords the patient a considerable amount of relief of pain.

Repeated myringotomies are seldom necessary if the original incision is properly made. Such an opening rarely closes prior to the time it has served its function of drainage. The fact that the membrane occasionally continues to bulge after incision or even after the opening has been sealed over must not be considered evidence of retained purulent exudate under pressure. It may be due, as was previously mentioned, to inflammatory changes within the drum itself, changes which are relatively slow in resolving.

The question might be raised, after the indications for myringotomy have been established, what are the hazards, if any, in waiting for spontaneous rupture? The answer to this question is included in the following outline of the advantages of myringotomy.

1. Immediate relief of symptoms is frequently afforded.
2. The likelihood of extension of the infection to the mastoid and adjacent structures is diminished.
3. Toxic absorption from a purulent focus is lessened.
4. Spontaneous rupture is not always followed by adequate drainage nor does

rupture always occur at the site of choice.

5. The principle implied in the dictum "where there is pus it should be evacuated" is maintained.

On the other hand, incisions of the drum made too early are not always free from an element of danger. Under these circumstances sufficient time has not elapsed for adequate walling off of the infectious process. Instances of intracranial complication attributed to too early incision have been recorded.

*Preparation of Patient for Myringotomy.* The external canal must be prepared by careful cleansing with peroxide of hydrogen or alcohol. Adequate illumination is very important, the reflected light is to be used whenever possible. The funnel of the aural speculum should be of the largest size admitted by the external canal. If the patient be an infant, below the age of two and one-half or three years, proper "mummification" in a sheet and careful holding are most essential. An anesthetic here is usually not required. In children above this age, and in adults, a general anesthetic is advisable, gas and oxygen or ethyl chloride proving most satisfactory. The blade of the myringotomy knife must be razor sharp.

*Site of Incision and Technique of Operation.* The site of choice for incision is the posterior inferior quadrant. This is based not only on a consideration of the anatomy of the tympanum but also on clinical experience. A study of the anatomy will reveal that the corresponding structures on the inner tympanic wall if projected from the tympanic membrane are, (1) the anterosuperior quadrant with the tympanic opening of the eustachian tube; (2) antero-inferior quadrant with the carotid canal; (3) postero-superior quadrant, long process of the incus, stapes, oval window, etc. and (4) postero-inferior quadrant, promontory.

It is obvious from this description that the most favorable site for incision and the least hazardous is the postero-inferior quadrant. The promontory situated here

projects outward and protects the underlying secondary tympanic membrane against trauma. The danger, although remote, of striking the jugular dome which occasionally protrudes into the hypotympanic cavity and which frequently presents dehiscences must always be borne in mind.

A curved incision parallel to the external canal wall and extending from 9 to 6 o'clock, or from 3 to 6, depending on the side, is made. This type of incision has the advantages over the linear one in that it is larger and it includes a greater number of the radial fibres of the drum. The retraction of these severed fibres keeps the wound open; better drainage is thus obtained. Incisions made in the postero-inferior quadrant have also proved most satisfactory in instances where the greatest expression of fullness is manifested elsewhere in the tympanic membrane. Under such circumstances the inflammation resolves in the usual manner without evidence of undue scarring in the drum.

Cultures of the pus from the middle ear at the time of myringotomy should be made routinely. Valuable information with regards to prognosis and subsequent therapy is often obtained.

*After Care.* Following incision it is advisable to carefully irrigate the ear with warm saline or boric acid solution, once or twice within the next eight hours, to

remove the blood clots from the margins of the perforations and from the external canal. This is to be followed by dry wiping of the canal with cotton swabs as often as necessary. The local application of heat and the use of a sedative usually suffice to keep the patient comfortable.

While in the vast majority of instances myringotomy affords almost immediate relief of symptoms, occasionally, however, particularly in the rapidly advancing infections and when this procedure is done prematurely the symptoms may continue. Also, it must be remembered that the spread of infection to the adjacent structures is not always obviated by this procedure.

#### SUMMARY

The surgical anatomy of the tympanum, the pathology, physical signs and symptoms of acute middle ear suppuration in the most common forms are briefly outlined. A clear understanding of all these factors, together with one's clinical experience, forms the basis of the otologist's judgment in the decision for or against myringotomy. Naturally the general condition of the patient must always be considered. It is for this reason that the close cooperation between the pediatrician or internist and the otologist is most essential.



# TREATMENT OF BOILS AND CARBUNCLES

DONALD GORDON, M.D., F.A.C.S.

Consulting Surgeon, Flushing Hospital and Dispensary, Perth Amboy and Tuxedo Memorial Hospitals

NEW YORK

**B**OILS and carbuncles form a scourge which must have afflicted the human race from prehistoric times, yet little effort appears to have been expended in any movement to diminish their prevalence during this period, other than to allay the local discomfort which commonly accompanies their presence.

The laity accept the first seven boils philosophically as Nature's method of ridding the blood of some noxious humor; and endure them as they do taxes, not always patiently, but as a necessary evil to round out life's experience of human suffering.

The medical profession seems to have assumed a similar attitude, overlooking a fountain source of staphylococci which is maintaining and spreading virulent organisms with a specific pathogenic selectivity for skin, the largest protective barrier of the body except the blood.

What happens to the staphylococci which are so commonly found in skin infections to cause them to become the active organisms of grave complications by invasion and dissemination within this natural protection, even in the absence of active skin lesions, has never been satisfactorily explained.

It is evident from the past history of both these skin and systemic infections, and our inability to prevent and control their recurrence adequately at the present, that preventative medicine and surgery are at fault in handling this problem. It, therefore, becomes our surgical responsibility to make an effort to lessen the recurrence, and hence the incidence of boils and carbuncles on patients being treated for them.

A great opportunity would seem to be afforded surgical research for the development of procedures which might diminish

this great source of staphylococci. A concerted attack on these two common and related lesions by preventative medicine, surgery, and bacteriology, should bring results of great and far reaching value.

Fifty-seven years ago the typhoid bacillus was unknown. From a disease which at that time caused an enormous death rate, it has at present become too infrequent to afford enough cases to teach the disease and its complications to medical students. This has been accomplished through practical sanitary measures, of vaccination, disinfection of bacilli carrying excreta, and isolation of carriers. All this developed in the period of time mentioned. The same may be said of diphtheria and other diseases.

Surgical departments could readily spare the required time from delving into obscure cavities of the body for rare and occult pathological lesions due to complications of the lowly furuncle to direct investigation toward diminishing this skin infection which might lead to an arrest of some of the ravages in the body due to staphylococcus infection. Organized research while seeking new diseases to conquer, should give at least passing attention to the prevention and cure of these ancient but still existing afflictions of man with the possibility in mind of their being one of, if not the great fountain source of all staphylococcus infections pathologic to man.

Curiously enough it appears necessary to have a high mortality attached to a disease to attract medical and lay effort to a study for checking its prevalence and progress; and when a conquest is assumed to be in prospect, the success of the means used to accomplish this end, is rated in terms of lowered mortality. It is obvious that this yard stick would be most difficult to apply to boils, though easily applicable



to carbuncles. The mortality of boils in hospital records however, is concealed in the enormity of the catastrophe of their lethal complications, caused through disseminated infection.

I believe the incidence and mortality of carbuncles are connected in a large degree with the furuncle bearer by his contribution of organisms with increased virulence and specific action to which is added his ignorant disregard of elementary principles of surgical cleanliness.

The prevention of the initial boil or carbuncle, I doubt can be avoided; but I am sure by painstaking energetic efforts, its incidence can be diminished, if the local spread and recurrence of cases of furunculosis which one sees and which have continued for several years, can be checked in a few weeks by simple surgical measures at present in use. Further knowledge regarding the pathological customs of the staphylococcus might help bring about the elimination of the staphylococcus carrier, who is disseminating infection to those with a low immunity. These becoming infected in turn pass on organisms of increased virulence which having developed specific action for the skin, do not necessarily confine their activity to this structure. Each small detail which can be added to the prevention of this cycle, will be an aid in diminishing the contaminating influence of the vast surface of bacteria bearing skin to which every human being is exposed and contributes daily.

That a person may contaminate the air with staphylococci is supported by data in an article by William and Mildred Wells<sup>1</sup> on "Air borne infection (sanitary control)" who find that the "organisms in the tubes taken at the Children's Hospital, Boston, both before and after irradiation of the air were observed to be predominately sarcinae and staphylococci, owing to the nature of the activities of the clinic. These organisms are characteristic of the skin and were raised into the air by the dressing and un-

dressing of the patients, together with the treatments which consisted largely of massage, manipulation, exercises, and so on." Earlier in this same paper, they state that "the *Staphylococcus aureus* and *albus* found in this study of air borne infections were more resistant than *B. coli* and *Streptococcus veridans*, and exceeded only by *sarcina lutea* in their resistance to ultra-violet radiation." Although the pathogenicity of these organisms was not worked up, these are very suggestive facts as an expression of the organisms resistance to destruction.

The important role that the staphylococcus plays as compared with other organisms when it involves the osseous structures, as an example of systemic invasion, is clearly shown in an article by Robertson<sup>2</sup> on osteomyelitis. A staphylococcus was found singly in 69.3 per cent of the cultures, and once in combination with streptococcus, and singly in 24 per cent of the blood cultures, and once in combination with streptococcus.

It would appear that concerted vigorous attack on infections of the skin due to these indigenous organisms might offer some relief from the many serious diseases with their high mortality which staphylococci cause in other deeper structures of the body. Attention seems to be concentrated on the most suitable operative procedures for a disease, the predominating causative organisms of which are known, with a casual disregard for the most apparent and fertile source of these. It is similar to the treatment of malaria before the mosquito was found to be the carrier of the infection.

I have indicated the need of preventing the spread of bacteria from a contaminated surface of one person to another. There is a more important need in preventing the spread of infection from any one single lesion to other parts of the same person to establish prevention and cure. The degree of meticulous care given the first lesion

<sup>1</sup> WELLS, W. F. and M. Air-borne infections: sanitary control. *J. A. M. A.*, 107: 1805 (Nov. 28) 1936.

<sup>2</sup> ROBERTSON, R. C. Acute hematogenous osteomyelitis. *J. A. M. A.*, 107: 1188 (Oct. 10) 1936.

seen by the physician not infrequently determines the duration of the disease.

The first lesion on the patient is rarely seen by the doctor. It is usually treated by the patient himself after consultation with the local pharmacist or "amateur quack." Until surgery offers better, this will continue so, or until some one climbing out of the rut will take notice of these old diseases and dramatize them sufficiently to attract professional and lay attention to their very probable important etiological relationship to all forms of staphylococcus infection with its high disability and mortality rate.

The individual is rare indeed upon whom some small follicular infection cannot be found, manifested in the redness about the opening of a hair follicle, sweat or sebaceous gland. The role these minute infections play in initiating and spreading the more important one to subjects with lowered immunity, will be a hard nut to crack; but I feel this will be done in the future by coordinated laboratory and clinical studies. That there is a relationship, appears suggestive in the degree of folliculitis seen in proximity to an established skin lesion under treatment, especially in areas sparsely covered with hair. Though we cannot request a patient to seek medical care for a pimple, it is incumbent upon every medical man to carefully treat and protect such small areas of infection to prevent spreading of it and recurrence of larger ones until immunity has been established. That such an immunity exists and is an important factor in overcoming gross infection is demonstrated by two facts, the self limited duration of so many cases which receive very poor attention; or the more important one, that every boil or carbuncle does not cause death, with or without treatment. Individuals who have manifestly a low resistance against skin infections should be taught to use every precaution against it until the cause of this lowered resistance has been corrected, or age has lessened their susceptibility sufficiently to prevent relaxing this vigilance.

The diabetic should use this care throughout life.

There are more closely related etiological factors which are so intermingled with treatment that for brevity sake, I will discuss them in their place. I will emphasize important features which have to be anticipated or treated during any stage of the treatment of furunculosis or carbuncles, as they may cause or follow each other.

The blond sandy complexioned individual whose skin becomes red from slight irritation, we cannot change. He requires that great care be taken to avoid any irritation or injury of the skin by solutions or dressings to avoid spreading the infection to adjacent parts; and careful attention to hygiene, adequate physical rest and protection against extraneous infection as well as his own. Anemia should be corrected, and the carbohydrate intake adjusted to actual requirements to avoid excess. This does not refer to the diabetic who requires closely observed, skilled diabetic care. Garments worn next to the skin should be of non-irritating texture, changed daily, and boiled or adequately washed and rinsed between changes. This holds good for all athletic garments worn during exercise. Avoid swimming in water contaminated by many bathers, followed by lounging on dirty sand beaches. The value of sunlight in improving the resistance of the skin is overshadowed by contamination and trauma by contact with sand. Youths should be cautioned against the careless use of unclean towels at boy's clubs, schools, or public swimming pools, etc. Until very recent years, the frequent disability of collegiate rowing crews was recorded in the daily press. Contaminated wrestling mats have made their contribution. All parts of athletic apparatus exposed to contact with perspiring parts of the body should be wiped with 1 per cent formalin solution frequently enough to avoid accumulation and transmission of infection. Lubricating oils have been found to cause an epidemic in workers about machinery. A person with furuncles should use every precaution

against contacts with other people, a precaution which others should see is carried out, especially in industry and in the home.

The cellular mass killed by staphylococcal infection may be small enough to quickly liquefy and near enough to the surface to merely form a drop of pus beneath the epidermis. This may dry up, form a crust which is rubbed off and onto another part of the body. The infection may pass deeper, destroy a mass of tissue of variable size, in which case it becomes a necrotic mass or slough which as it separates from the healthy tissue, liquefies as pus; pressure and pain develop, and through necrosis of the overlying tissue the pus may spontaneously evacuate itself relieving pain by diminishing tension. Tenderness, pain, and toxemia continues until all the slough becomes separated, which Nature accomplishes in about ten days. Coincidentally with the complete separation of the slough, pain and tenderness and the purulent discharge cease, and there is left a granulating cavity to be filled. *Until this cavity has granulated to the surface it discharges infected serum*, and continues to do so until the surface of the granulation tissue is epithelized, not closed with a crust which is formed from the infected serum. These crusts tend to prevent healthy granulations filling the existing cavity by preventing drainage. When desquamated these crusts become the most important carriers of infection to other parts. A slough once started, I believe takes ten days of healing period from its inception until it is separated sufficiently to be expressed. If deep, this necrotic mass becomes completely liquefied after an adequate time period. The pus from a lesion near the surface may be evacuated by necrosis of the overlying tissue; but if deep, it will necessitate drainage by incision. If the foci are multiple and extensive, the subcutaneous tissue is involved and the infection spreads until tension is released by adequate drainage, or the process progresses and a carbuncle forms.

On this brief pathology, the treatment is based. A small lesion can be completely

excised, and the wound left open for drainage and healing; but such a procedure is not advisable, as the protective barrier is removed and the infection left in the lymphatics affords a better chance for systemic invasion. When a boil is incised before an adequate liquefaction of the slough has occurred, the protective zone is injured and a new slough forms on the edge of the incision which will take several added days to separate. The boil which has advanced to a point of partial liquefaction surrounded by a better protective zone, can be incised with less danger of disseminating infection and a minimum of sloughing along the incision which delays convalescence.

The all important requisites to the treatment of a boil or carbuncle are (1) primarily to promote liquefaction of the slough; (2) to give early drainage for the pus under pressure and maintain it as is indicated in any abscess; (3) to prevent the discharge from spreading the infection, and to aid in increasing the local and systemic resistance.

Nature's method of affording drainage is by necrosis of the overlying tissues, which can be aided by moist heat, keratolytic drugs such as salicylic acid ointment of from 1 per cent to 5 per cent, or incision. Moist heat can be applied in the form of sterile compresses wet with hot boric acid solution, or Thiersch's solution covered with cellophane to prevent evaporation. Saline though comforting, as it becomes concentrated, tends to cause additional folliculitis if kept up for any period of time. Magnesium sulphate solutions rapidly become concentrated, leaving a rigid encasement of irritating crystals which lend nothing to the comfort of the patient nor cure of the disease. Magnesium sulphate is one of the good drugs which in recent years has been prostituted from its proper pharmacological use as a cathartic to the role of a placebo unworthy of surgeons. Salicylic acid 1 per cent in boric ointment U.S.P. No. 11, is a soothing antiseptic ointment which should be used on the contigu-

ous skin surface to prevent folliculitis and additional boils, or applied generously over an incised lesion beneath either wet or dry dressings when these are used, prevents coagulation of exudate which interferes with drainage. This is especially valuable when laxity permits wet dressings to become dry.

When more energetic softening of the superimposed tissue is indicated, to open an existing pustule, Klotz's formula of salicylic acid in the form of an emplastrum as given in Brewer's "Text-Book on Surgery,"\* is most valuable. I have used it for a great many years to afford drainage of small pustular lesions, protection against and treatment of folliculitis, and to prevent an infection from spreading. This emplastrum offers the simplest and most efficient dressing for small single or multiple lesions one can use. It affords the only method of which I know for patients to protect themselves against small follicular infection, preventing recurrence, and larger ones. This emplastrum is used by melting a small amount on the point of a spatula over a flame, dropping this in the center of a small circular piece of adhesive plaster, and while still melted it is flattened, then allowed to cool to a dull lustre to avoid causing a blister in which the pus will collect. This "paster" is then applied to the lesion after all the hair has been removed by shaving with a sterile razor and cleansing with alcohol. To remove this paster, the margin is grasped with sterile forceps and a small cotton ball soaked in benzine held in another pair of forceps is

used to float off the paster. Under no circumstances should the trauma of pulling this paster off be permitted, as doing so injures the mouths of glands and hair follicles and predisposes to infecting them. After removal in this manner, the benzine is wiped away with alcohol, or witch hazel which is more soothing. If the surface requires cleansing, use a little hydrogen peroxide in tincture of green soap, followed by alcohol again. These pasters are used to cover a very small isolated but tender follicle infection. If gentle pressure on the paster elicits tenderness after twenty-four hours, it is changed for a new one, otherwise they are left on for several days before removal, at which time the infection will have subsided. In the case of a draining or moderately large lesion, they are changed daily or even twice a day if the drainage is enough to show at the margin of the paster. Under this dressing, a small furuncle will open and drain without contaminating the surrounding parts. The pasters are continued, changed as indicated, and left on until the wound is healed by complete epithelization, which it will do in contact with the salicylic paste. As I have suggested above, an infected crust from a so-called healed lesion dropped on the skin and rubbed with the clothing will reinoculate like the old method of vaccination with the crust of cowpox.

Patients with arrests of infection are instructed to equip themselves with the necessities for these procedures and to apply a paster on any pimple or red area which develops in the future. Any and all procedures connected with the caring for the condition must be carried out meticulously by the doctor and patient, and with the same interest that they give their game of golf.

I have taken this up at length, because I believe it to be one of the greatest adjuncts to the treatment of boils and carbuncles in eradicating autoinfection at present available. I have been grateful for its aid for twenty-five years.

\* The pharmacist from whom I obtain the modified emplastrum Klotz has kindly suggested that after the ingredients are melted by heat and mixed by stirring, the mixture is allowed to cool to half the temperature required to melt them. The mass is then kneaded under water with the hands, and when cool and solid enough, it is rolled into cylinders 6 cm. long and 1.5 cm. in diameter, as a convenient size for use.

#### MODIFIED FORMULA OF EMPLASTRUM KLOTZ

|                        |      |
|------------------------|------|
| Emplastri plumbi.....  | 60.0 |
| Emplastri saponis..... | 25.0 |
| Petrolati.....         | 8.0  |
| Cerae alba.....        | 20.0 |
| Acidi salicylic.....   | 5.0  |

A lesion which is not draining and whose size and depth preclude the use of emplas-trum salicylate Klotz, or in which the tension is associated with tender lymph nodes, incision is indicated and should be opened under a local anesthetic. Local anesthetics injected by direct infiltration into the induration of a boil cause pain by tension until the anesthetic takes effect, and five minutes should be allowed for it to act. Where the tissues permit, blocking is more desirable. The ethyl chloride spray used to freeze and harden the surface over a tender boil, followed by pressing on the frozen surface with a dull knife, is a poor form of local anesthetic. In blocking carbuncles great care and judgment should be used to avoid spreading infection with the injecting needle, and a general anesthetic is preferable if the patient is a suitable risk.

A boil which has been adequately incised at the right time, will require no more than a piece of rubber dam for a drain, aided by 2 per cent salicyclic acid ointment to keep the incision open. When the slough extrudes sufficiently to act as a drain, do not pull it out, but see that it does not prevent drainage. When it is separated, it will fall out on the dressing. Using large thumb forceps to force gauze wicks into these small openings is a cruel and unnecessary trauma and affords poor drainage; use fine non-toothed eye forceps to introduce the rubber dam.

Areas surrounding any of these lesions should be shaved sufficiently to prevent adhesive plaster used in dressings adhering to any existing hair. Benzine again should be used to float off such adhesive followed by alcohol and careful cleansing with hydrogen peroxide and green soap. There are skins which develop a slight redness showing a sensitiveness to any irritation. These should be treated with calomine solution without carbolic acid until the irritation has subsided.

This covers the general principles of treatment for lesions on any part of the body except specific regions which call for special procedures in conjunction with the

above. The region within the area enclosed by a horizontal line extending through the external canthi of the eyes, one through the angles of the mouth, and two vertical ones connecting the canthi and mouth angles may contribute infection to the cavernous sinus via the angular, ophthalmic, and other veins. Therefore any pyogenic infection of this region is of major importance in its relation to causing cavernous sinus infection and thrombosis. Walton Martin<sup>3</sup> has reported a mortality of 6 of 7 cases of infection of the upper lip and nose admitted to St. Luke's Hospital, New York. The 6 that died had been pricked, cut, or squeezed. He emphasized the need of using atraumatic procedures to avoid complications by injury to the small veins about the lesion which are thrombosed. Batson<sup>4</sup> of the Graduate School of Medicine, University of Pennsylvania, has demonstrated on the cadavar that ligation of the angular vein does not prevent substances injected into the facial vein being carried into the cavernous sinus by several other routes. This has removed a great burden and confusion in my own mind regarding whether it should or should not be done in the presence of infection in this region, and when. I have always felt that it was unnecessary trauma of doubtful value in a dangerous region. The burden of proof in its favor has still to be proved by those advocating it.

The specific technique for caring for furuncles and carbuncles of the nose, upper lip, and face in the above region is as follows. The patient is placed in a hospital bed in the sitting position, body high, to avoid swelling of the face and the knees flexed to prevent slipping down; this position is maintained day and night. Along side of the bed, a table is placed on which is an electric plate with switch under the patient's control. On this there is a basin of boric acid solution which is kept hot.

<sup>3</sup> MARTIN, WALTON. The fatal outcome of certain cases of staphylococcus infections of the face and lips. *Ann. Surg.*, 76: 13 (July) 1922.

<sup>4</sup> BATSON, OSCAR V. Oral communication from unpublished studies of "Anatomy of the Head."

Salicylic acid 5 per cent in boric acid ointment (without wax) is well rubbed into several layers of a gauze pad, leaving an excess on the surface. Then the heavily impregnated two upper layers are removed from the underlying layers. The ointment bearing layers are then cut with sterile scissors into squares just large enough to cover the most prominent part of the lesion. These are laid together with a pair of sterile forceps inside a sterile towel resting on the table. A rectangular piece of rubber dam long and wide enough to hold an adequate hot compress against the lesion is pleated at each end and tied with a piece of umbilical tape or string. The string should be long enough to make a sliding, adjustable loop which passes behind the ears and holds the rubber dam in place without pressure. The infected area is covered with one of the small pieces of gauze spread with the salicylic salve, a large piece of good absorbent cotton is placed on top of and held in place with the rubber dam mask (Fig. 1). The cotton is then kept continuously wet with the hot solution by the patient, using a medicine dropper to moisten the cotton. The cotton and the greased gauze is changed P.R.N. by the patient using the sterile forceps with the aid of a looking glass. As drainage begins, changing and cleansing with soft cotton is required more frequently. When the slough presents, it should not be pulled upon or squeezed until after the tenth day, at which time, if it has not expressed itself, it can be gently teased out. These procedures should be maintained until the evacuation of the slough and subsidence of the greater part of the induration has taken place. The cavity should then be treated with 1 per cent salicylic ointment until epithelized. The horizontal position is permitted as soon as the slough is out. When the multiple openings of a carbuncle demand connection, 95 per cent carbolic on a blunt probe or an electrothermic knife may be used to accomplish this, using great care to avoid injuring any tissues except those surrounded by a protective barrier.

For the small deep so-called "blind boil" of the laity, which occasionally occurs in this region, hot moist compresses are used

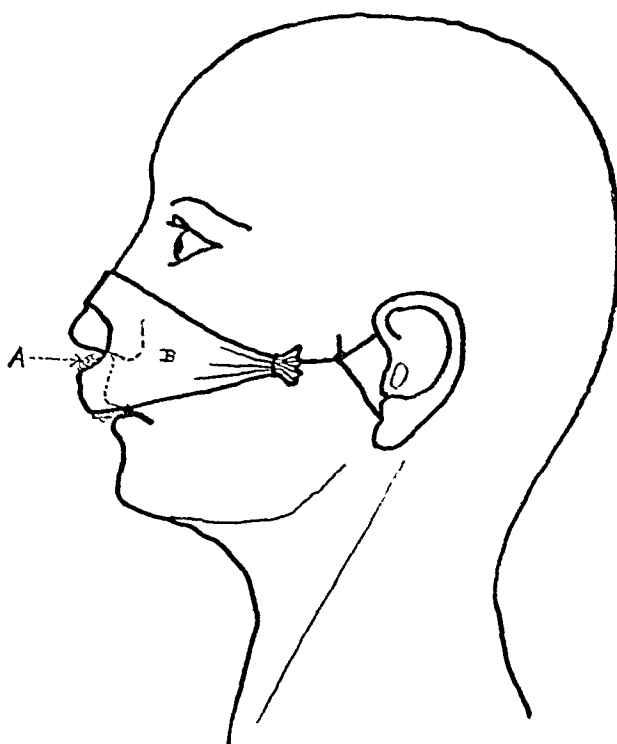


FIG. 1. Drawing illustrating the use of rubber dam mask to hold upper lip and face compresses. A, absorbent cotton and dressings; B, rubber dam mask.

until the slough is completely liquefied. The area is then anesthetized and opened carefully with a sharp Von Graef eye knife, making a small wound. A piece of spear-shaped rubber dam is introduced with plain eye forceps, and salicylic ointment used with hot moist dressings.

The nasal furuncle can be prevented by simple lubrication with boric ointment. If the tenderness is persistent, 1 per cent salicylic acid in boric ointment is soothing and healing. If the process goes on to suppuration, crusts should be removed with hydrogen peroxide as a mechanical cleanser. This is applied on a small cotton wound applicator gently rotated over the surface. When the crust is loosened, it will wipe away on the swab. When the area is carefully cleansed, a 2 per cent salicylic acid in boric ointment is generously applied. This routine is carried out frequently during the day to insure drainage and

comfort. In addition hot moist dressings of absorbent cotton applied frequently will give comfort until the slough is evacuated.

One of the most emphatic "*don't's*" in surgery is *don't squeeze, puncture with a needle or sharp instrument these lesions*, to prevent injuring the protective barrier which has formed around these minute infections.

The painful recurring furuncle of the external auditory canal if treated by frequent cleansing and the application of 2 per cent salicylic ointment, is made more comfortable and the spreading of infection lessened.

Furuncles on women's necks were rarely seen until the bobbed hair style necessitated clipping and shaving the back of the neck. The barber shops modern aseptic technique is a gesture in the right direction, but calls for more adequate sterilization of tools between clients who may be staphylococcus carriers. The period of time edged tools are exposed in the formalin cabinet or that clippers are boiled, is too short for effective sterilization. A barber clips the hair on the neck of one susceptible to staphylococcus infection. The clippers may have been used on the neck of a client recently afflicted with boils and whose skin and hair are contaminated, or perhaps there are a few infected follicles as mentioned, or a tiny infected crust harboring staphylococci. The infected clippers are pressed into the skin of the non-immune, contaminating it; and if they are dull, they pull the hair traumatizing the hair follicle. Infection is further augmented by the hair which has been cut short and thereby stiffened, being pressed into the follicle by the collar, folliculitis develops, and it is a short stage to furuncle or carbuncle. Not infrequently in the less modern shops, there is an added touch of infection when the barber uses the obsolete but germ laden brush to wipe cut hair away from the neck while he drives the infected bristles into open hair follicles and sweat glands. A client's own tools adequately sterilized will prevent primary contamination, but in

their absence washing the neck immediately with soap and water, witch hazel or alcohol, will be of service in preventing primary or secondary infection, especially where a razor has passed through an infected follicle.

The attached shirt collar contaminated by secretion from a dressing becomes a real hazard. The neck should be protected against such reinfection until the collar can be removed or replaced by a detachable one. Where much discharge is present, a large dressing held in place by a soft neck bandage covered with a washable hunting stock is desirable. The stock should be changed daily and laundered. Contaminated overcoat collars of either cloth or fur should be washed with 1 per cent formalin solution. Driving in open cars where dust is deposited on the neck and rubbed in by collars require that the neck should be protected by frequently changed and clean mufflers, as well as washing with tincture of green soap.

Women who in recent years have shaved the axilla, used depilatories, and irritating astringent deodorants, are very prone to axillary furunculosis. Here the lesion by reason of the loose subcutaneous tissue burrows and balloons the surface with only moderate pain before an outlet is afforded. The large lymph flow in this region makes for a profuse discharge of watery pus and a gelatinous slough. The quantity of lymph interferes with their healing by forming a boggy granulation over which epithelization progresses slowly. Also the movement of this region interferes with healing and dressings. These lesions are most intractible but yield to simple and meticulous surgical cleanliness and care. To avoid the trauma involved in removing adhesive plaster, a dressing support as shown in the sketch (Fig. 2) is used. Two of these should be made so that they can be laundered frequently. The local dressing is supported by sterile absorbent cotton permitting movement of the arm without local irritation. Disinfection of the contaminated sleeve armholes and dress shields with 1 per



cent formalin solution and the avoidance of any irritating deodorant are essential.

In the male, intertrigo of this and in the

tissue, the loss of which will make for prolonged convalescence. They will extend to and involve the deep fascia. In the initial

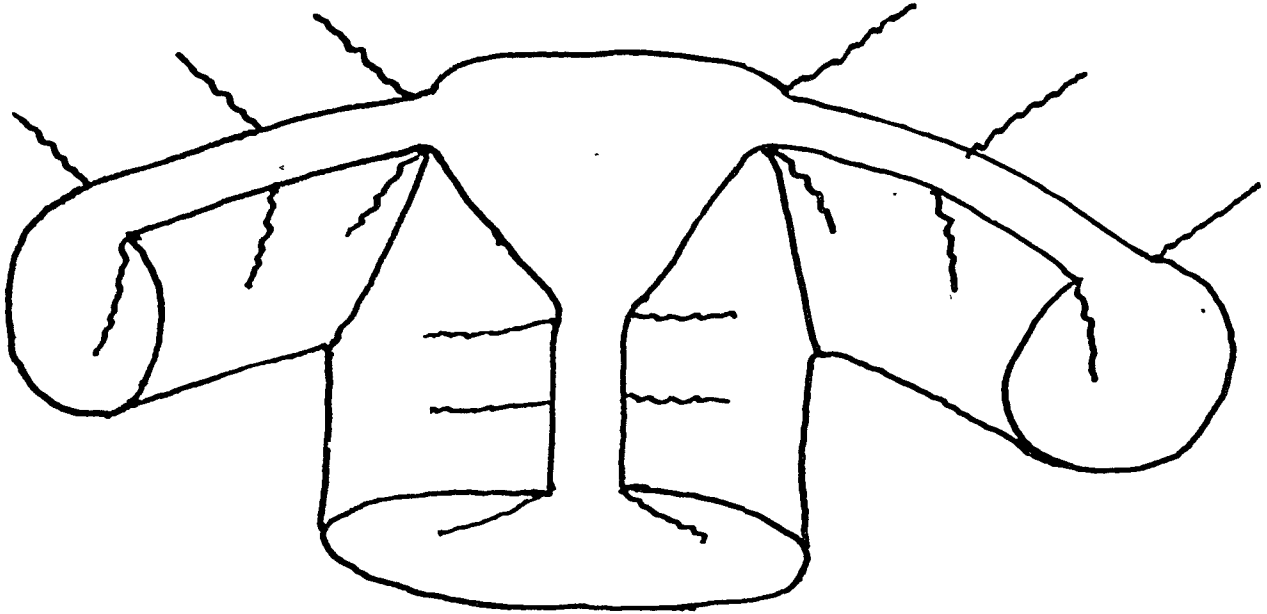


FIG. 2. Drawing illustrating the thin muslin garment with tapes to hold axillary dressings in place.

perineal and internatal regions is a predisposing factor, and should be treated with mild soothing antiseptic lotions or weak salicylic ointment. Pruritis of the skin about the anus and internatal fold furnish bacteria which are spread to other parts of the body by the finger nails. This together with intertrigo of the perineum and groins should be sought and treated in recurring stubborn cases. A slight discharge from a small anal fistula or pilonidal sinus can furnish a persistent recurring infectious agent.

Doctors and nurses are conspicuously remiss in handling infected dressings with ungloved hands and without instruments. It is imperative for one doing dressings of boils and carbuncles and infected cases, to always use instruments to handle the dressings and sponges, and sterile gloves where possible to avoid contaminating themselves, associates, and patients. It seems absurd to have to mention this, but its justification will likely be apparent to the reader at his next surgical rounds.

Carbuncles are most apt to form in the thick skin of the posterior cervical and upper dorsal region. The infection may spread laterally and involve large areas of

stages one treating these lesions should not overlook the possibility of an infection from anthrax or glanders and proceed accordingly.

A small infection with three or four closely grouped openings can be treated as a boil unless it presents a picture of spreading induration with slight tenderness. Then it should be treated as a carbuncle. In a carbuncle, one should not wait for liquefaction of the slough. The progressive extension by invasion of surrounding tissue outruns localization. Hot moist dressings are used until it is learned where the maximum necrosis has taken place, to determine the type and extent of the incision. As the pressure due to swelling cuts off the local blood supply to a degree which prevents the tissue resisting the spreading infection, early drainage by operation should not be delayed too long, as it affords release of the subcutaneous tension, and prevents extension of infection. The sooner this is done the less destruction of tissue there will be and the shorter the period of convalescence.

In the diabetic, any suppurative process tends to maintain a high blood sugar. This calls for a more complete and immediate



eradication of the suppurative or necrotic lesion than in one who is not. The diabetic should be prepared by his medical advisor, or placed under the control of the medical service in a hospital where his diabetic needs will receive proper dietetic and insulin control. Surgery is merely an adjunct to this, and complete excision should be carried out at the earliest possible moment compatible with his diabetic pathology and preparation.

Operative procedures for other than the smallest lesions should be done in a hospital. It affords an assistant for retraction and exposure to remove necrotic tissue and control bleeding, as well as a surgical nurse and anesthetist.

I prefer general anesthesia to avoid passing needles through infected tissue and local postanesthetic reaction. The prone position necessitated by lesions of the neck and upper back interferes with respiration and calls for skilled anesthesia with resuscitation support available.

The incision used should be determined by how much skin can be saved which at the same time will permit complete removal of all necrotic subcutaneous tissue, or a relief of lateral tension by removing a subcutaneous wedge-shaped section from the surrounding infected region. The removal of the wedge leaves an over-hanging margin which supports a blood supply to aid separation of sloughs. I believe this relieves tension better than simple undercutting. The incision can be crucial, H-shaped, or circular. One should attempt to avoid acute angles which tend to slough and produce unsightly scars. The incision can be made with a cutting endothermic knife and bleeders stopped with the coagulating current. When done by sharp dissection, a very small heavy full curved needle carrying a ligature to take a bite of tissue to prevent the ligature slipping, is very helpful to control bleeding. The local tissues are very thick from swelling, and one should go well underneath the necrotic mass to the deep fascia. Removal of a portion of the deep fascia facilitates vasculari-

zation and separation of the slough that remains. If all the slough is not removed, it will separate provided incisions have been adequately made to relieve the tension. When major oozing has been stopped by temporary packing, a Mikulicz packing is made with two or three layers of plain gauze wet in sterile saline or boric solution, and with the margins of the incision held open, a small wet packing is used to fill it and the reenterant angles and crevices. The whole is covered with loose moist gauze and a Carrel tube placed in position to maintain constant moisture by irrigation. This is covered with a piece of boiled cellophane and a layer of sterile absorbent cotton to prevent movement of the bandage being transmitted to the tender wound.

The outer dressing is changed in twenty-four hours, and the central packing as soon as it is softened enough by discharge to be removed easily, then it can be replaced with moist loose packing. The layers of gauze in contact with the granulations are left until they lift from the wound surfaces without causing bleeding. The surrounding area is cleansed with alcohol and  $H_2O_2$ , and covered freely with 1 per cent salicylic ointment. The adjacent areas are watched daily for induration and tenderness which lasts until the slough is completely separated. If the excision has been complete, there will be little; if incomplete, some sloughing will occur and gradually lessen; but if induration and tenderness progresses further, excision should be done. Boldness at the start will save future trouble. It is surprising how much smaller a wound becomes after the swelling has subsided and all the slough separated. From this point, a simple vaseline gauze packing can be used until the cavity is level with the skin margin. If this packing overlaps the skin edge, epithelization will advance over the marginal granulations as they rise in the wound. The surrounding skin must be kept clean by daily dressings and cleansing. The small isolated furuncles which may develop around the operative area, will be less when 1 per cent salicylic acid ointment has been

used. These are treated with Klotz's emplastrum on adhesive plaster as already described. When the granulations are level with the skin, boric ointment on the granulations covered with flamed adhesive changed every two days, will promote epithelization from the margins and prevent exuberant granulations. Large cavities should be Carreled and skin grafted before granulations have formed an excess of scar tissue beneath them. In hair bearing areas the wound margin should be examined under a bright light with a large magnifying glass, and marginal hairs should be treated with an epilating forceps. Those that are loose and slip out easily should be removed, but unless they come out freely without any discomfort, leave them alone. These loose hairs act as foreign bodies and prevent healing by causing a minute degree of foreign body irritation. Until epithelization is complete without a crust, the wound is not adequately healed.

Before discharge the patient should be instructed how to care for any small follicular infection which might develop, and to use all the prophylactic measures possible. Hydrogen peroxide is not used for its antiseptic value which is nil, but for its mechanical cleansing. I have used a single application of gentian violet and methylene blue 5 per cent solution in 70 per cent alcohol as advised by Kingsley Roberts for skin infection over limited areas with success in conjunction with the above principles where discoloration of clothing and laundry was not a factor. I believe it is an excellent penetrating, non-irritating skin disinfectant with a prolonged action.

Iodine is not mentioned as I never use it in treatment or preparing these lesions for operation. It is an irritant, hardens the surface skin and permits infection to progress

beneath it. Soap and water followed by ether is sufficient.

The use of vaccines in the presence of careless surgical cleanliness are of little value and should not be relied upon to do a surgeon's work. However, in conjunction with careful clean surgery they are occasionally an aid in stubborn cases.

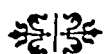
I believe that in the future further study of the staphylococcus should bring to the surgeon's aid great help from newer vaccines.

I have made no endeavor to enter the discussion of the newer methods of treatment which have not been sufficiently used to warrant advocating them for general use. A thorough study of existing principles of surgery as related to these lesions together with a due appreciation of their application to the different phases of the changing pathology of boils and carbuncles limited though it is, will afford judgment to evaluate properly any new principles of treatment. I know of no specific.

The material I have given has been used for many years. Four facts I have learned are requisite—drainage, gentleness, cleanliness and thoroughness.

#### SUMMARY

1. Surgical responsibility regarding these lesions;
2. The relationship of these lesions to the perpetuation and spread of all staphylococcus infection, i.e. carriers;
3. The relationship of staphylococcus carriers to generalized staphylococcus infection;
4. General principles of prevention and care of furuncles and carbuncles;
5. Specific treatment and methods for lesions of face, lip, nose, and axilla; and
6. Treatment of carbuncles are all presented and discussed.



# FURUNCLE OF UPPER LIP\*

GERALD H. PRATT, M.D., F.A.C.S.

Instructor in Surgery, New York Post-Graduate Medical School and Hospital, Columbia University

NEW YORK

FOR eighty-five years the peculiarities of an infection of the upper lip have caused special studies to be made and reports to appear in the medical literature, but in spite of a great deal of observation the mortality remains approximately the same. Stromyer's (1855-60) conception that a furuncle on the upper lip was merely the outward manifestation of a pre-existing and underlying infection gave way to Trendelenburg's (1886) thought that such a malignant infection must be due to a specific infection. Failure to show such a specificity, led Trendelenburg later to believe that it was a mixed infection of the mouth. Lenhartz and Lexer (1903) followed with proof that in most instances the causative organism is the common furuncle germ, the staphylococcus. Other organisms may be found and Kocher showed that the streptococcus may be present (Lexer-Bevan 1908). Efforts to find a particularly malignant form of infecting organism shows that our predecessors realized that in this locality an ordinary infection took a different and often fatal course.

Rosenbach of Gottingen (1905) was one of the first to draw attention to the difference in the anatomy of the host in this syndrome, and to clearly understand this entity a brief anatomical review is necessary.

Fascial planes as a rule limit infection and guide its course. In the part of the face we are considering the muscles have no fascia and the skin is closely attached to these muscles of expression. This does two things. It gives no fascial area to limit and collect the infection and it also keeps the skin in this area in constant movement whenever the facial muscles move. This motion constantly pumps septic material into the surrounding tissue spaces thus

making the splinting of the infected part difficult. A second anatomical consideration is one of vascular importance. This area is richly supplied with a deep vein plexus which normally drains by way of the facial vein into the internal jugular vein. A tributary of the facial vein, the angular vein, anastomoses with the superior ophthalmic vein at the inner upper angle of the eye, this superior ophthalmic vein being the major tributary of the cavernous sinus. None of these veins have the protective valves present in veins in other parts of the body. A progressive thrombosis of the facial vein diverts the normal venous current to the angular vein and with thrombosis of it and the superior ophthalmic vein a thrombosis of the cavernous sinus is the result (Fig. 1). (A more circuitous course for venous drainage to the cavernous sinus by the pterygoid plexus is less common.) The cavernous sinus is so constructed that it consists of many small compartments, physiologically designed to slow the blood flow and thus prevent too sudden changes in the intracranial pressure due to respiratory influences. This condition lends itself more readily to thrombosis. We have therefore, two very good reasons for the difference in the course of a supposedly mild infection in this portion of the body.

In addition to these anatomical peculiarities in the pathogenesis, one must place the maltreatment of the patient by himself or often by the attending physician who follows an old dictum "*Ubi pus, ibi evacua.*" Many practitioners do not realize that if recovery is to be expected in infections above the mouth area, the axiom "*Noli me tangere*" must be followed.

The symptoms and course of this condition are best exemplified by a case

\* From Department Surgery, New York Post-Graduate Medical School and Hospital of Columbia University.

history, the record taken from a distant relative, a senior in law school on the threshold of his professional life. This history amply illustrates the tragic suddenness of disaster from its simple beginning.

Male, aged twenty-one, developed a small pimple on the upper lip near the angle of the right nostril, which was treated by compresses, salves, etc., at home for three days. He was then taken to a nose and throat specialist who applied suction on two occasions. Edema spread rapidly and the eye became swollen and entirely closed. Twenty-four hours later the other eye became closed and a proptosis of the original side appeared. Delirium with high fever showed evidence of the septicemia. He was removed to the hospital where all forms of supportive and restorative treatment failed to arrest the course. Death occurred on the tenth day.

*Remarks.* This is the usual tragic story of the patient at the beginning of a useful career whose life expectancy of some thirty-five years more is suddenly broken. Earlier and very conservative therapy might have been more efficacious.

Every mistreated pimple on the upper lip will not follow such a serious course. Every day many pimples on the upper lip are squeezed without serious results. It is important to realize, however, that in such instances, a certain percentage will go on to dangerous or fatal complications. It is sufficient if we thus derive a wholesome respect for this lesion and treat each simple pimple as a potentially dangerous adversary, thus preventing the complications.

The treatment necessarily divides itself into the stage of the disease when first observed.

1. *The Pimple.* If the pimple is not disturbed it will invariably subside. This natural subsidence is due to a protective wall of leucocytes built up by nature around the site. Squeezing, rubbing, incising or the application of irritating pastes or solutions disturb this natural barrier and the spread of infection is expedited. Great care in the explanation of the potential danger to the patient is necessary at this time. If the pimple is large, the patient

should be kept in bed, talking prevented, and the movement of the lips in deglutition minimized by the use of fluids. General

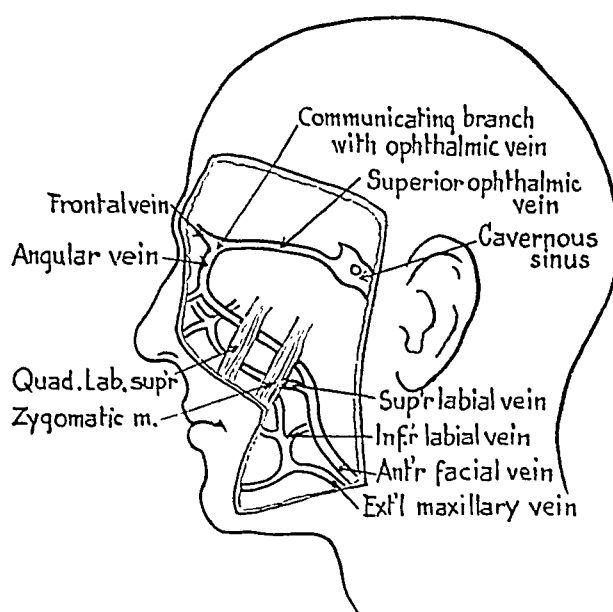


FIG. 1. Dissection showing anastomosis between facial and ophthalmic veins.

body care, maintenance of nutrition and elimination are important measures.

2. *The Furuncle.* The patient is placed in bed at once with careful nursing care. Talking is prohibited and all movement of the lip prevented, utilizing the feeding tube if necessary. General care is maintained including the fluid balance and elimination. Sedatives to control the pain and restlessness are administered as required. Locally, a light cotton pad, kept moistened by a dropper, eliminating the trauma of changing the dressing may be placed over the lesion, the solution used varying with the desires of the attending surgeon provided it is non-irritating. Its effect is only to help keep the surface elimination of the area open and to give some local comfort. An ointment such as 5 to 10 per cent of yellow oxide of mercury may be placed on the area; the ointment by its mild macerating action keeps the small sinuses from coagulating. Such a dressing eliminates the weight of the pads.

3. *The Complication Stage.* The development of a spreading infection as evidenced by swelling, redness and tenderness extending up along the nose to the eye and forehead is a grave warning. The treatment as outlined in the furuncle stage

must be continued. Expert nursing care is important. A strictly conservative program as far as the local lesion is concerned is necessary. Nature's effort is to splint and immobilize the area, and any interference with this effort will be followed by disaster. The swelling, the edema, the induration are all a part of this defense, and for the mobilization of every resistive element absolute quiescence of the part is required. The therapy then may be summed up as excellent nursing care, the provision of ample nourishment without the use of the lips, fluids, care as to elimination, seda-

digested by the recipient, will often provide the extra added defensive element temporarily lacking, and when this defense is destroyed by the patient, it can be replaced. Experience has shown that this occurs approximately every three days. Immunized donors are apparently of help, and the use of bacteriophage as shown by MacNeal has been effective in many instances, especially when combined with blood transfusions.

4. *Cavernous Sinus Thrombosis.* This condition is associated with pyemia and septicemia and the end result is nearly

COLLECTED STATISTICS

| Source                    | Total Cases | Conservative Treatment | Conservative Per Cent Mortality | Operative Treatment | Operative Mortality | Remarks                              |
|---------------------------|-------------|------------------------|---------------------------------|---------------------|---------------------|--------------------------------------|
| Bier's clinic.....        | 182         | 182                    | 8.2                             | ..                  | .....               | 1/3 upper lip                        |
| Dittrich.....             | 40          | 18                     | 5.5                             | 22                  | 13.6                |                                      |
| Breslau.....              | 73          | 36                     | 2.7                             | 37                  | 10.9                | Melchior                             |
| Morrison.....             | 28          | 28                     | 0.0                             | ..                  | .....               | Magnesium sulphate paste             |
| Marburg.....              | ..          | ..                     | ..                              | ..                  | .....               | Injected own blood; good results     |
| Lexer clinic (Wrede)..... | 8           | 8                      | 0.0                             | ..                  | .....               |                                      |
| Rodelius.....             | 218         | 218                    | 11.0                            | ..                  | .....               | Injected own blood; good results     |
| Carp.....                 | ..          | ..                     | ..                              | ..                  | .....               | Magnesium sulphate with good results |
| Crain.....                | ..          | ..                     | ..                              | ..                  | .....               |                                      |
| Bullock.....              | 26          | ..                     | ..                              | 26                  | 27.07               |                                      |
| Cutler.....               | 23          | 13                     | 21.7                            | 10                  | 50.0                | Includes lip, nose, cheek            |
| Martin.....               | 7           | ..                     | ..                              | 7                   | 84.71               | Extensive infections                 |

tives for the pain and restlessness, sponging for hyperpyrexia and delirium, and for the local lesion a splendid surgical restraint. Visitors, consultants who do not fully realize the situation or who disagree with the therapy, and insistent relatives can easily turn the tide fatally at this stage, and success or failure may depend on the artful control of the family and friends. The development of an early confidence in the kin is highly important and sooner or later with continued surgical inactivity this confidence will be tested. The use of blood transfusions in small repeated amounts (250 c.c. every two to three days) is valuable in this stage. This blood, which like all foreign proteins is

always death. Spontaneous cures have occurred even in this stage and supportive measures and blood transfusions should be continued. Operative therapy on the cavernous sinus is not advocated even though Browder in Brooklyn, and Eagleton both have reported a surgical cure, Browder coagulated the entire cavernous sinus and while the eye was lost, the patient was saved. Other experiences have but hastened the fatal outcome, and have eliminated the occasional cure from general supportive measures and blood transfusions.

The ligation of the angular or facial veins before the spread of the infection has been utilized by many, and in certain instances quite miraculous results have

been reported. Theoretically, this plan does not seem a wise one. The placement of a ligature with its necessary operative procedure, violates the conservative plan of therapy outlined which has been found to give a lower mortality than any other course of treatment. Some years ago, a similar plan was used to eliminate the danger of pulmonary thrombosis from thrombophlebitis of the leg. An incision with ligation of the involved vein just proximal to the thrombus resulted fatally in the first 2 instances showing the fallacy of attempting to limit thrombus extension by ligation. There is always some phlebitis and the added irritation from the operation is often sufficient to spread the clot. At the stage that ligation would aid, there is usually a septicemia or a septicopyemia, and previous to this time most will recover with the conservative treatment. One is inclined to believe that the reported cures after ligations were in spite of rather than because of this operation. The frequency of bilateral sinus thrombosis also makes one dubious of such treatment. X-ray therapy has been advised for this condition and while it has so far not been established, it may be worthy of trial. The response of some furuncles to roentgenotherapy has been dramatic. Two personal instances failed to respond to this type of treatment. Circuminjections of the patient's own blood as advocated by Bailey, also are not as effective in this area as in the other parts of the body and again violates the "let alone" policy. Mobilization of defensive cells may be better done by whole blood transfusions or immunized donors. Suction, to which the older laryngologists so frequently resort, has directly contributed to the mortality.

In 8 patients recently treated as outlined in this paper there has been no mortality.

#### SUMMARY

1. Anatomical causes for the severity of furuncles of the upper lip are outlined.
2. The part that maltreatment or overtreatment plays in the pathogenesis is described.

3. A therapeutic outline for the four stages of the disease is arranged.

4. An ultra-conservative treatment is advocated.

#### REFERENCES

- BAILEY, HAMILTON. Ligature of the angular vein as a preventive measure in facial carbuncle. *Surg. Gynec., Obst.* 46: 565-567, 1928.
- BIER. Quoted by Crain, R. C.
- BULLOCK, W. O. Carbuncle of the upper lip with special reference to the prevention of cavernous sinus thrombosis. *Surg. Gynec. and Obst.*, 14: 156-158, 1912.
- Case 13242. When not to squeeze a pimple. *Boston Med. and Surg. Jour.*, 196: 1009-1010, 1927.
- COLLER, FREDERICK A. Infections of the lip and face. *Surg. Gynec. and Obst.*, 60: 277-290, 1935.
- CRAIN, R. C. Discussion by Jurgens, H. J. The deadly upper lip infection. *Illinois Med. Jour.*, 55: 273-276, 1929.
- CURRY, G. J. Infections of the lip. *Jour. Mich. State Med. Soc.*, 27: 340-341, 1928.
- CUTLER, ELLIOTT C. Infections of the lip and face. *Surg. Gynec. and Obst.*, 60: 289-290, 1935.
- FOOTE, EDWARD M. Local surgical treatment of infections of the face. *Am. Jour. Surg.*, 6: 438-442, 1929.
- HINTON, J. W. Danger of infection about face. *Ann. Surg.*, 85: 104-106, 1927.
- HUDSON, W. L. Staphylococcus infection of face and lips. *Texas State Jour. Med.*, 22: 337-340, 1926.
- JURGENS, H. J. The deadly upper lip infection. *Illinois Med. Jour.*, 55: 273-276, 1929.
- KAHN, MAURICE. Infections of the lip. *J. A. M. A.*, 82: 1043-1044, 1924.
- KOSLIN, IRWIN. Primary staphylococcus infection of the nose, lips and face. *Ann. Surg.*, 94: 7-14, 1931.
- LANG, O. Lipfurunkel. *Nederl. Tijdschr. v. Genees.*, 64: 2495, 1902.
- LENHARTZ, HERMAN. Die Septischen Erkrankungen, 1903, p. 262.
- LANZ, O. Furuncle on the lip. *J. A. M. A.*, 76: 348, 1921.
- LEVIN, OSCAR. Treatment of furuncles; plea against incision. *Med. Jour. and Rec.*, 131: 253-256, 1930.
- MARTIN, WALTON. The fatal outcome of certain cases of staphylococcus infections of the face and lips. *Ann. Surg.*, 76: 13-27, 1922.
- OCHSNER, E. H. Discussion, Jurgens, H. J. The deadly upper lip infection. *Illinois Med. Jour.*, 55: 273-276, 1929.
- PRICE, JOHN W. Treatment of infections of the face. *Ann. Surg.*, 85: 329-332, 1927.
- RODELIUS. Malignant furuncle of the lip. *Klin. Wchnschr.*, 2: 2348-2353, 1923, Abst.: *J. A. M. A.* 82: 506, 1924.
- ROEDER, C. A. Ligation of the angular vein in infections of the upper lip. *J. A. M. A.*, 90: 272, 1928.
- ROSENBACH. Concerning malignant furuncle of the face. *Arch. f. klin. Chir.*, 77: 715, 1905.
- SHEELY, C. A. Carbuncle with especial reference to that of the upper lip. *New Orleans Med. and Surg. Jour.*, 80: 807-809, 1928.
- STROMYER, TRENDLENBERG. Quoted by Bullock. *Surg. Gynec. and Obst.*, 14: 156-158, 1912.
- WHEELER, W. I. DE C. The danger of sepsis about the lips. *Irish Jour. Med. Sc.*, pp. 369-371, 1926.
- WREDE. Quoted by Martin.

# SALIVARY FISTULA\*

DEAN CURTIS, M.D.

Instructor in Surgery, New York Post-Graduate Medical School, Columbia University

NEW YORK

THE salivary glands supplying secretions to the mouth include the follicles of the mouth, the sublingual, the submaxillary and the parotid glands. The latter three are paired glands on either side of the mouth. The sublingual glands secrete a thick mucilaginous secretion, the submaxillary glands a somewhat thinner secretion containing mucin, while the parotid glands secrete a thin watery fluid. All these are mixed to form the saliva, which softens food into a pliable bolus and starts the process of digestion. Ordinarily about 1000 to 1500 c.c. of saliva are secreted by these glands daily.

In considering the embryology of the salivary glands, we may understand their anatomical position and their vulnerability to fistulous formation. The anlage for the submaxillary and the sublingual glands first appear about the sixth week of embryonic life. It is a ridge-like area of the buccal epithelium occupying the furrow marking the angle between the tongue and the floor of the mouth. The sublingual anlage lies nearer the tip of the tongue. The parotid anlage appears about the eighth week and is a development of the oral ectoblast along the lateral groove, separating the upper and lower jaws. At first, the submaxillary and parotid anlages lie about equally removed from the oral opening but migration occurs, the former passing forward and the latter backwards. All these glands begin as a solid cylindrical outgrowth from the deeper layers of the epithelium. The cylinder rapidly lengthens and branches, so that by the eighth to the tenth week, the submaxillary and parotid glands, respectively, consist of a main stalk and terminal buds. The anlage of the sublingual gland gives off epithelial buds

and the primary sprouts subdivide, eventually becoming the smaller ducts and the glandular tissue. With the submaxillary anlage moving forward in the buccal development, it becomes closer associated with the sublingual gland and develops a duct (Wharton's duct) of 3 to 4 cm. in length. The ducts of the sublingual glands vary in number from four to twenty or more and are less than a centimeter in length. The largest one (Bartholin's duct) is inconstant and usually opens to the lateral side of the submaxillary duct. Because of the posterior migration, the parotid gland develops the longest duct (Stenson's duct) which is about 5 cm. in length.

From an anatomical standpoint the submaxillary gland comes to lie under cover of the mandible, just anterior to the angle of the jaw, in a fossa on the inner side of the bone. As, however, the skin is carried medially under the jaw at this point the gland appears on the surface. It projects little, if at all, on the outer side of the mandible but curls around the posterior border of the mylohyoid muscle and extends for some distance in the floor of the mouth under the mucous membrane in the angle between the mylohyoid and the hyoglossus muscles. The duct runs from the front of the main body of the gland along the floor of the mouth under the mucous membrane to open into the mouth through a little papilla on either side of the frenulum of the tongue. This gland lies in loose structures of the mouth and is supported by the deep fascia of the neck. At no position is the duct superficial to expose itself to outside injuries.

The sublingual gland, the smallest of the salivary glands, rests against the sublingual

\* Department of Surgery, New York Post-Graduate Medical School, Columbia University.

fossa of the mandible, close to the symphysis and lies on the mylohyoid muscle in the floor of the mouth. Its posterior extremity is in contact with the anterior prolongation of the submaxillary gland. The sublingual gland, which secretes a mucilaginous secretion is favored by opening into the mouth by several short ducts. This gland is not superficial, thus it is not exposed to injuries from the outside. With the sublingual and submaxillary glands lying in the floor of the mouth, there is almost a continuous layer of glandular tissue, part lying in the sublingual region and part lying in the submaxillary region. This area is completely protected by the mandible and at no position are the ducts exposed.

On the other hand with the anlage of the parotid gland moving posteriorly, it comes to lie behind the upper part of the ramus of the mandible, in front of the mastoid process and below the external auditory meatus and the zygomatic arch. It is supported by the deep fascia of the neck which sends septums into the gland, and is most difficult to be dissected from the gland. The gland overlaps the ramus of the mandible, both medially and laterally. The duct of the parotid gland is formed by two chief tributaries and emerges from the front of the gland, above its middle, running forward and a little downward across the masseter muscle to turn sharply at its anterior border. It then crosses a mass of fat and runs obliquely through the buccinator muscle and mucous membrane to empty into the mouth opposite the second upper molar tooth. A portion of the gland and duct become superficial over a bony surface, thus favoring injuries from the outside to cause fistulous developments. If the gland or duct should be injured, it practically always affixes itself to the skin margin, developing a fistula.

For practical consideration all salivary fistulas develop because of a break in the continuity of the gland or the duct, whether due to injury or obstruction in the duct and rupture of the proximal portion. Obstruction may arise from concretions or infec-

tion. A salivary fistula from the gland proper which is usually a small lobule lends itself to local treatment and will usually heal spontaneously. If developed from the duct, where we have a continuous flow of saliva, it is difficult to treat and rarely heals without surgical intervention. Most of the salivary fistulas are derived from the parotid gland and its duct. These have been found in the external auditory meatus from a misplaced portion of the gland, also as a complication in surgery of the mastoid region and with injuries over the area of the parotid fossa or the ramus of the mandible. Similar to other tubes of the body, as the biliary or the urinary ducts, the ducts of the salivary glands develop lithiasis, causing obstruction of saliva, followed with rupture of the viscus or infection and ulceration, thus producing a fistula. The parotid duct, because of its location, is most vulnerable to injury and is the most difficult to respond to treatment.

A salivary fistula is usually a very small opening on the skin. There is a constant wetting of the area from the flow of saliva, which is increased by the stimuli to the gland, whether chemical, mechanical, electrical, thermal or psychical. The fistula may be probed, but only when connected with the duct will a probe be admitted for any distance. To determine whether dealing with a true salivary fistula or a bronchial fistula, it is better to collect the secretion and apply the chemical test. Mucin, a constant product of saliva, is a glyco protein, insoluble in water or dilute acid but soluble in dilute alkali and can be precipitated from the saliva by dilute acid or alcohol, or by saturating with ammonium sulphate. It gives the usual protein color reactions but is not coagulated by heat in neutral solution. We may apply the digestive action of saliva to carbohydrates. The opalescence of a starch solution will gradually disappear if saliva is added. Also starch gives a blue color with iodine. As digestion progresses, the dextrins are formed, which give a reddish color with iodine.



In the treatment of salivary fistulas the operations designed are to transplant the sinus tract in order to have the drainage into the mouth. It is only when the ducts are injured that such plastic operations may be performed. De Guise has an operation in which a piece of silk is threaded through two needles and the needles are carried through the cheek into the mouth. The silk surrounds the fistulous tract and when tied within the mouth brings the proximal portion of the tract closer to the mucous membrane. It is better to incise the mucous membrane, so that it is more likely that the fistula will empty into the mouth. The skin portion of the tract is freshened and sutured. If it is possible to transplant the fistulous tract within the mouth by plastic operation, it is the surest procedure. Dilatation of the tract may follow.

If the fistula arises from the gland proper, there may be one or more sinuses. In such a case it is better to treat the gland locally with phenol or cautery, endeavoring to exterminate that area of the gland. An escharotic agent of undoubted value in the treatment of glandular fistulas in contrast to duct fistulas is Cutler's solution. This is to be reapplied using pressure and allowing the tract to close gradually. When saliva forms beneath the skin, local pressure over the area sometimes will prevent the further development of a fistula. At the time of an injury of a salivary duct great care should be taken to approximate the edges. The duct should be sutured, but not allowing the suture to pass into the lumen of the duct, and pressure should be applied. Remember always to make sure that the distal portion of the duct is open. This is done by passing probes from the oral opening. If the duct is injured close to the gland, it may be necessary to tie the duct proximally, and in this manner allow atrophy of the gland. Atrophy only will take place if no infection is present. Favorable results have been recorded by the use of x-ray therapy or the division of the auriculotemporal nerve in order to diminish the secretion from the gland. With the use

of x-ray irradiation Meyers feels that it is better to use an accumulative dose of x-rays until the secretion is stopped, rather than a massive dose. If any operation in the region of the parotid gland, such as excision of neoplasms, hemangiomas, abscess or parotid tumors, is contemplated, it is a safe move to pass a filiform through Stenson's duct in order to identify this structure. In obstruction of the duct the structure will roll easily under the finger where it passes over the ramus of the mandible.

The treatment of sublingual fistulas is clinically unimportant as the fistulous orifice always opens into the mouth and never on the skin.

With submaxillary fistulas it is better to excise the gland as plastic operations are unsuccessful and are usually followed by stricture and calcareous formations. The gland lends itself to surgery because of no septums passing in to the gland from the supporting fascia and it lies in loose tissue which is easily dissected.

#### SUMMARY

1. The majority of salivary fistulas arise from the parotid gland and its duct, usually the result of lacerations, whether surgical or traumatic.
2. Diagnosis of salivary fistulas is established by a study of the secretions from the fistulous tract.
3. Salivary fistulas of the gland are treated with local cauterization with external pressure; of the duct, by an attempt at transplanting the fistulous opening into the mouth or elimination of the gland completely.

#### REFERENCES

- SCHRIEDER, *Ann. Otol., Rhinol. and Laryngol.*, 26: 1917.  
 BLAIR and PADGETT, *Arch. Surg.*, 7: (July) 1923.  
 SMITH and TONGERSON, *Surg., Gynec. and Obst.*, 41: 318-319 (Sept.) 1925.  
 TEES, *Can. Med. Assn. Jour.*, 16: 145-146 (Feb.) 1926.  
 SIMPSON, *South. Med. Jour.*, 22: 215-216 (March) 1929.  
 ABERCROMBIE, *Jour. Laryngol. and Otol.*, 45: 474-476, (July) 1930.  
 PORTMAN, *Ann. Surg.*, 101: 1175-1180 (May) 1935.  
 DACOSTA, *Modern Surgery*.  
 MEYERS, Personal communication.

# ACUTE PYOGENIC PAROTIDITIS\*

JOHN HENDERSON, M.D.

Instructor in Surgery, New York Post-Graduate Medical School, Columbia University

NEW YORK

ACUTE pyogenic parotiditis is the subject of a voluminous and controversial literature. It is, nevertheless, of especial interest to the general surgical and medical practitioner because of its occurrence as a postoperative complication and a concomitant of various debilitating illnesses.

Suffice it to say, by way of historical comment, that the condition has received the attention of physicians since the time of Hippocrates, who refers to it in the "First Book of the Prorrhethika." Pliny, Galen, and Celsus refer to it in their writings, and Paulus Aeginet described at some length a method of treatment. Since that time, down through the moderns, beginning with Virchow in 1858, there have been almost countless contributions to the literature, a further review of which would be superfluous, as excellent analyses will be found in the papers of Jennings, Rankin and Palmer, Custer, Blair and Padgett, Talbot and others.

## ANATOMY AND PHYSIOLOGY

The parotid is a compound racemose gland, lying on the posterior half of the masseter muscle, below the ear, and behind the angle of the jaw. Posteriorly, it is in contact with the external auditory canal; this is of great significance, as abscesses sometimes point at this site. The gland discharges its secretion into the mouth through Stenson's duct, which arises from the upper anterior portion of the gland, about 1 cm. below the zygoma, and runs in an imaginary line connecting the tragus and the center of the upper lip. Its opening is on an easily visualized papilla opposite the second upper molar, and on gently evert-

the cheek may be catheterized. Operative trauma to the duct is more likely to result in a fistula than is injury to the gland itself.

The gland is enclosed in the dense parotid fascia, which is an extension of the cervical fascia, and is continuous with the masseteric fascia and the deep fascia of the neck. There may consequently be an extension of the infection into the deep planes of the neck, and downward over the anterior chest wall, involvement of the breast having been noted.

Depending upon the location within the gland, the pus, if unrelieved in tension, may perforate into the external auditory canal, or into the temporomaxillary joint. It may also work its way between the pterygoid muscles, around the carotid artery and open into the pharynx. It may erode through the carotid artery or jugular vein, or break through the encapsulating fascia and burrow down the neck. Because of the denseness of the overlying fascia, or in the case of a deeply situated abscess, it is often difficult to determine the presence of fluctuation, and, hence, the tendency is sometimes to delay drainage too long after suppuration has actually occurred.

The blood supply of the gland is received via numerous twigs from the superficial temporal artery. The external carotid, after entering the gland, divides into the temporal and internal maxillary arteries, the former giving off, in the substance of the gland, the transverse facial artery, which runs forward between the zygoma and the parotid duct. Also within the gland, the temporal vein unites with the internal maxillary vein, which, after receiving the

\* From the Department of Surgery, New York Post-Graduate Hospital, Columbia University, service of Dr. Charles Gordon Heyd.

posterior auricular vein, empties into the external jugular. The facial nerve, after emerging from the stylomastoid foramen and entering the substance of the gland, gives off numerous filaments; a large trunk usually accompanies Stenson's duct, running just below it.

This gland is peculiar, in that it often contains one or more well defined lymph nodes. The lymphatic drainage is into both the superficial and the deep chains of cervical lymph glands.

Many drugs, such as atropine, morphine, and many analgesics, cause a diminution of salivary flow and should be avoided from a point of view of prophylaxis. Drugs, such as iodine, bromine, mercury, lead, quinine, and several others, are partially excreted through the salivary glands, and may possibly be a factor in lowering the resistance of the gland to infection. During the induction stage of anesthesia, salivation is copious, but then diminishes, and is not reestablished until many hours after the patient has reacted.

These physiological facts are of especial significance in relationship to pathogenesis, prophylaxis and treatment.

#### PATHOGENESIS AND BACTERIOLOGY

Probably the most discussed question throughout the literature has been that of etiology. All the discussions delineate themselves into one of five lines of thought:

1. Parenchymatous degeneration of the gland due to the heat of pyrexia;
2. Degeneration of the gland due to the toxins of the primary disease;
3. Degeneration produced sympathetically following operations on the generative organs;
4. Infection of the gland by organisms derived from the blood stream;
5. Infection of the gland by ascension of bacteria from the mouth through Stenson's duct.

For practical purposes, the two latter modes are the only ones which merit consideration. Infection via the lymphatics can, of course, occur, but presupposes a

source of infection within the lymphatic radius of the gland, and such is not frequently demonstrated. Direct trauma, and infection following obstruction of the duct, are obvious and need not be considered here.

While it would be quite illogical to assume that all infection must occur by one or the other route, the majority of modern opinion favors the ductogenous route as the one followed in the majority of cases, and while there is no reason why hematogenous infection should not occur, it is difficult to adduce indisputable evidence, clinically and bacteriologically, that such be the case.

The basic work along these lines was done by Rost in 1914, who concluded that the pathologic picture was the same whether the gland became infected via the duct or the blood stream. In 1931, Berndt, Buck and Buxton, in attempting to corroborate the preceding work, found marked differences in the pathologic picture produced, so that from a given microscopic picture, the mode of infection could be predicated.

Bacteriologically, the most common infecting organism is the staphylococcus, usually aureus, although the streptococcus and pneumococcus are not rare. The *Bacillus typhosus* has been isolated in pure culture in cases of typhoid fever, but this is not necessarily significant because the organisms are present in many of the parenchymatous organs during the disease. In general, the failure to correlate the organism isolated from the gland with that from the primary infection, constitutes *prima facie* evidence that the condition is not metastatic. It is also noteworthy that the organisms usually infecting the gland are those which exist normally in an avirulent state in the mouth and lower part of Stenson's duct. In addition, most cases show evidence of infection of the duct, pus being present at the orifice.

Furthermore, there are numerous factors which favor the ascent of infection. In debilitation and acute infections, there occurs a lowering of the general body

resistance, and, therefore, a relative increase in the virulence of the normal buccal bacterial flora. Diminution of salivary secretion and flow occurs in fever, dehydration, vomiting, and restriction of fluids, and is an important predisposing factor. Pawlow has shown that reflex cessation of salivary flow accompanies laparotomy and visceral manipulation. As has been noted, salivation ceases for some hours following general anesthesia, in addition to which mechanical pressure on the gland by the anesthetist or apparatus may occur, thereby tending to lower the resistance to infection.

Certain facts which support the hematogenous theory, however, must be taken into account. Parotiditis can be produced by the injection of organisms into the nutrient artery. The parotid is usually alone involved, the submaxillary and sublingual glands being unaffected, and it may be argued that this hypothecates a predilection of the gland for organisms circulating in the blood stream. Fisher maintains that the majority of cases are hematogenous in origin.

Rankin well epitomizes the situation when he says: "... facts were not discovered which would substantiate a single type of cause in all (cases)."

#### PATHOLOGY

The pathology is the same as that of an acute inflammatory process leading to suppuration in any other similar type of tissue. Grossly, there may be many small isolated abscesses throughout the substance of the gland, but more frequently the entire gland is brawny and indurated. Gangrene of the entire gland has been noted. Microscopically, it is seen that the parenchyma of the gland is involved, rather than its supporting structure. In ductogenous inflammations, the ducts are distended with exudate, the larger radicals showing the principal involvement, with destruction of the lining epithelium. Certain areas will show where the infection has broken through the duct wall, causing small

multiple abscesses containing chiefly polymorphonuclear leucocytes. There is little or no change in or about the blood vessels.

In hematogenous infections, the ducts are less involved, with more involvement of the small radicals than in ductogenous infections. The arterioles show swelling and hyperplasia of the lining endothelium, with occasional thrombus formation. The reaction around the ducts is more of a mononuclear than a polynuclear one.

#### OCCURRENCE

Acute pyogenic parotiditis is usually thought of as a postoperative complication, but it occurs with almost equal frequency in non-surgical conditions, although it is no longer very common. Of all cases treated at the New York Post-Graduate Hospital during the past sixteen years, we were able to find only 30 cases of acute parotiditis.

The condition may occur during any period of life, but in several series of cases which have been reported, it has been found to occur most frequently in the third decade. More cases are seen in women than in men, but this probably is due to the fact that morbidity is higher in females than in males. There is also an apparent seasonal trend which parallels the incidence of upper respiratory infection, the greatest number of cases occurring from November to April, inclusive. A few of the cases apparently occur as a primary disease, or secondary to an acute nasopharyngitis or the extraction of a tooth. Four of our 30 cases had suffered no previous illness.

Many of the older observers were impressed with the frequency with which parotiditis occurred following pelvic operations, particularly those on the gonads, and attempted to account for this phenomenon by postulating an intrinsic relationship between the gonads and the parotid gland, following the analogy of the frequent involvement of the gonads following mumps.

The affection has followed almost every type of surgical procedure, but apparently it occurs more often after pelvic operations and those carried out in infected fields. In

his article on postoperative parotiditis, Rankin comments on the fact that in a large series of cases, the complication occurred 17 times as frequently following operations on the colon as in a series of general surgical cases.

Of non-surgical conditions, the literature contains countless reports of the condition occurring as a complication of typhoid fever, pneumonia, typhus fever, scarlet fever, diphtheria, measles, cholera, dysentery, malaria, plague, influenza, erysipelas, puerperal sepsis, infectious arthritis, tuberculosis, tularemia, and dengue fever. It may also complicate any of the chronic debilitating diseases, such as the blood dyscrasias, cardiac disease, cirrhosis of the liver, kidney disease, and diabetes.

Both sides are involved about equally, and between 22 and 33 per cent of the cases are bilateral.

This is well summarized by Blair and Padgett, who list the primary conditions upon which this complication most frequently supervenes, as follows:

1. As part of a postoperative complex;
2. Following an infected wound in any part of the body;
3. In the course of any acute infectious disease, most particularly typhoid fever and pneumonia;
4. In any severe asthenic state;
5. As a terminal condition.

#### PROPHYLAXIS

Prophylaxis is of exceeding importance and is predicated upon the facts and principles already alluded to. The points upon which especial emphasis should be placed are:

1. Scrupulous maintenance of oral hygiene through adequate dental care prior to operation and during the period of morbidity, together with the frequent use of antiseptic mouth washes;
2. Maintenance of a free flow of saliva, by avoiding, in so far as is possible, those drugs already mentioned which decrease salivary secretion. The administration of as

much fluid by mouth as is compatible with the nature of the case, and the use of chewing gum or some other common sialogogue;

3. Maintenance of the general well being of the patient and the avoidance of extreme cachexia by transfusion or other means, with special attention to the maintenance of an adequate positive water, chemical, and caloric balance. The avoidance of untidy or dirty surroundings, and the prevention of sordes and decubitus ulcers, in addition to provision for meticulous nursing care in general.

#### SIGNS AND SYMPTOMS

The onset of acute parotiditis is usually sudden and quite striking, so that one is immediately aware of a change in the existing clinical syndrome. In cases, however, in which the virulence of the infecting organism is low, the onset may be insidious with gradual swelling of the gland, slight elevation of temperature, and little pain.

As a rule, there is a sudden rise of temperature to as high as 105 degrees F., accompanied by swelling in the parotid area, and extreme pain over the gland, usually to such a degree that motion of the lower jaw is difficult or impossible. With the onset, the patient becomes rapidly more toxic in appearance, and will attempt to avoid all movement involving the head, jaw, or neck.

The gland is usually hard and indurated and its borders are not difficult to define. In most cases, the opening of Stenson's duct is swollen, reddened, and pouting, and droplets of purulent saliva or frank pus will exude from it. If the vital reserve of the patient has not been unduly depleted by the primary disease, a high leucocytosis will be found.

With the extension of the infectious process, a spreading edema occurs, causing the eye on the affected side to swell shut, and it may extend downward over the neck as far as the clavicle. It may also extend inward to the pharynx and involve the glottis, resulting in asphyxia. Delirium

may occur, and in children convulsions are quite likely to supervene in the course of a severe infection.

The location of the preliminary or primary pain may vary according to the location of the process within the gland. Swelling of that portion of the gland lying in the glenoid cavity immediately in front of the external auditory canal, will cause pain in the ear, simulating otitis media, especially in children, and in the temporo-maxillary articulation. Swelling of those portions of the gland lying on the internal pterygoid muscle, and between the external carotid artery, causes severe pain and fulness in the throat, simulating a nasopharyngeal affection. When the lower jaw is opened, the space posterior to it in which the gland lies, is diminished, thereby pinching the gland against the bony meatus and mastoid process, so that it is impossible to open the mouth widely.

Gangrene of the gland, when it occurs, is fatal. On theoretical grounds, involvement of the seventh nerve should frequently occur, but, clinically, at least, it is almost never seen.

#### TREATMENT

Treatment demands surgical judgment. The question of paramount importance, of course, is when to incise and drain the gland. The answer is sometimes difficult to give, owing to the fact that the physical sign of fluctuation is difficult to elicit, and, hence, it is hard to tell when suppuration has actually occurred. There are many who feel that incision and drainage should be done at the earliest possible moment, but, on the other hand, both Rankin and Fisher have pointed out the effectiveness of early expectant and conservative treatment. Both recommend the deferring of operation until the clinical picture, as evidenced by increasing temperature and leucocytosis, shows that subsidence is not taking place, and makes surgical intervention imperative. Under these circumstances, the process may often have sufficiently localized itself

so that a minor surgical procedure will accomplish more than a radical one would have in the instance of early interference.

There are many cases, however, which undergo complete subsidence under conservative measures; these are the cases of low virulence, those occurring in patients not seriously debilitated by other disease, and most of the primary or "idiopathic" cases. The measures most commonly employed in such instances consist of the forcing of large quantities of fluid by mouth, or if this is not possible, parenterally; the application of cold to the gland during the initial stage, followed later by hot applications to hasten localization; the use of antiseptic mouth washes; chewing gum where its use is not too painful or impossible; and frequent catheterization of Stenson's duct by means of graded whalebone filiform dilators until the orifice of the duct will admit a blunt 22 or 20 gauge needle.

Probably the greatest contribution to the treatment of acute infections of the parotid gland was made by Rankin and Palmer in 1930. They observed that by using radium, and particularly by its immediate application to the gland on the first appearance of swelling, that they were able to materially reduce the incidence of suppuration and thereby the morbidity and mortality. A large dose is not necessarily more effectual than a medium sized one; the main necessity is early application. The maximum dose found necessary was four applications, eight hours in duration, at intervals of eight hours, of four 50-milligram tubes of radium. The filtration used was 2 mm. of lead, 1 mm. of brass, and 0.5 mm. of silver; the distance was 2.5 cm., and the total milligram hours 6605. The minimal dose was two applications, eight hours in duration, at intervals of eight hours, of 50 milligram tubes of radium, with filtration as stated. The total milligram hours were 800.

Under this regimen, for the first twenty-four to forty-eight hours, there is either no change in symptoms, or a slight exacerba-

tion. At the end of this time, a rapid subsidence begins, and in the less severe cases, the patient is well recovered by the fifth or sixth day. With this form of treatment, surgical intervention rarely becomes necessary, and the mortality is vastly reduced. Taking all factors into consideration, this is probably the treatment of choice where its use is available.

For those cases which demand surgical drainage, a number of incisions have been recommended. All have their advantages and disadvantages, the main points to remember being adequate exposure, and the avoidance of injury to important structures.

The incision recommended by Fisher is "Y" shaped, the stem being made along the vertical ramus of the jaw, and the limbs extending anteriorly towards the zygoma, and posteriorly towards the mastoid process. This gives good exposure and is anatomically safe.

The incision used by Blair and Padgett is one which starts 2 cm. in front of the ear, at the lower border of the zygoma, running back to the ear, and then downward to behind and below the angle of the jaw. Along this line the facial nerve lies deeply and is further protected by making multiple punctures into the gland with a blunt curved hemostat, making certain that no lobes of the gland are overlooked. The wound is packed open with iodoform or plain gauze and a pressure bandage applied. Relief of symptoms is almost immediate. Fistula rarely results following this operation. For general use, this method probably gives the safest and best exposure, and the most satisfactory end-results.

It is sometimes possible to determine the presence of a definite, small, circumscribed area in which the localized tenderness is of maximum degree. In such cases a small incision may be made over this area with the introduction of sharp Kelly forceps, the glandular tissues spread apart, and a small rubber tissue drain inserted. This is known as Hilton's procedure and will often obviate extensive surgery.

Regardless of the method of specific therapy chosen, it is essential that supportive therapy be carried out to a maximum degree, with especial attention to the water and chemical balance of the patient, and maintenance by the various means available of an adequate caloric intake. This is of the utmost significance in regard to prognosis, as it is our feeling that the mortality in these cases is not due to the parotiditis *per se*, which is really, in most instances, a secondary manifestation, but to the original disease.

#### PROGNOSIS

The death rate as reported by various authors, varies from 33 per cent in those cases requiring incision, to 42.8 per cent for all cases in the series reported by Blair and Padgett. In the 30 cases studied at the New York Post-Graduate Hospital, there were 8 deaths, or a mortality of 26.6 per cent. All these deaths occurred in cases in which the prognosis at best was extremely hazardous, and only one of the cases of parotiditis was primary.

In Rankin's series of cases treated with radium, the mortality was 5 per cent, which is significant when compared with other figures. Many clinicians feel that the parotiditis itself can only rarely be considered as the cause of death. In most cases the affection is merely a concomitant complication, and the original disease, or some significant factor, must be regarded as the lethal agent.

#### SUMMARY

1. Acute pyogenic parotiditis is of medical and surgical importance.
2. The preponderance of evidence seems to indicate that the majority of infections are ductogenous, rather than hematogenous in origin.
3. The histopathologic pictures produced in the two instances are dissimilar and sufficiently characteristic to predicate the mode of infection in a given instance.

4. The majority of cases are caused by the *Staphylococcus aureus*; *Staphylococcus albus*, the various streptococcic strains, pneumococcus, and *Bacillus typhosus* occur, but with far less frequency.

5. The affection has its highest incidence in females during the third decade, and during the months of November to April, inclusive. It follows many medical, as well as surgical conditions.

6. Prophylaxis rests on scrupulous oral hygiene, a free flow of saliva, and maintenance of general bodily economy.

7. The most characteristic clinical signs are pain and swelling in the parotid region, pyrexia, and leucocytosis.

8. Treatment consists of supportive and conservative measures, with recourse to surgery in the event that these prove futile. If radium is available, and its use can be controlled by one who is competent to do so, it will probably afford the most effective means of treatment.

9. The affection in the majority of cases is not of itself lethal; death should usually be attributed to the original disease, or to some other complication.

#### REFERENCES

- ANTUPIT, L. Postoperative parotitis in abdominal surgery. *Tr. Sect. Obst., Gynec. and Abd. Surg.*, 49: 53, 1927.  
 BERNDT, A. L., BUCK, R. and BUXTON, R. VON L. The pathogenesis of acute suppurative parotitis. *Am. Jour. Med. Sc.*, 182: 639-649, 1931.

- BLAIR, V. P. and PADGETT, E. C. Pyogenic infection of the parotid glands and ducts. *Arch. Surg.*, 7: 1-36, 1923.  
 CHARLTON, P. H. Postoperative parotitis. *Ann. Surg.*, 93: 837-843, 1931.  
 COLLINS, C. U. Parotitis as a postoperative complication. *Surg. Gynec. and Obst.*, 28: 404-407, 1919.  
 COMBS, C. N. Postoperative suppurative parotitis. *Anesth. and Analg.*, 7: 92-94, 1928.  
 CUSTER, R. P. Acute suppurative parotitis. *Am. Jour. Med. Sc.*, 82: 649-661, 1931.  
 DEEVER, J. B. Postoperative parotitis. *Ann. Surg.*, 69: 128-130, 1919.  
 ELTERICH, T. O. Purulent parotitis in the newborn. *Jour. Ped.*, 3: 761-764, 1933.  
 FISHER, W. H. Treatment of postoperative suppurative parotitis. *Ann. Surg.*, 86: 445-448, 1927; Postoperative infective parotitis. *Ann. Surg.*, 77: 568-571, 1923.  
 HOBBS, W. H., SNEIERSON H. and FAUST, L. F. Acute and chronic infections of the parotid gland. *Surg. Gynec. and Obst.*, 54: 555-563, 1932.  
 HOBBS, W. H. and SNEIERSON, H. Infections of the parotid gland. *Am. Jour. Surg.*, 32: 258-271, 1936.  
 JANKELSON, I. R. Septic parotitis in gastric hemorrhage. *Med. Jour. and Rec.*, 135: 517-518, 1932.  
 JENNINGS, F. D. Postoperative salivary gland infections. *Am. Jour. Surg.*, 8: 1201-1203, 1930.  
 LAYMAN, D. W. Pyogenic infection of the parotid gland. *Jour. Ind. State Med. Assn.*, 24: 465-472, 1931.  
 LILIENTHAL, H. A method of incision of the parotid abscess without injury to the facial nerve. *Am. Jour. Surg.*, 31: 101-102, 1917.  
 MULLER, G. P. Davis' Applied Anatomy. Ed. 8. Phila., J. B. Lippincott Co., 1929.  
 NOVAK, E. and ANTUPIT, L. A. Postoperative parotitis. *Med. Jour. and Rec.*, 122: 249-251, 1925.  
 PEIGHTAL, T. C. Postoperative parotitis with a report of cases. *Am. Jour. Obst. and Gynec.*, 11: 88-95, 1926.  
 RANKIN, F. W. and PALMER, B. M. Postoperative parotiditis: treatment without and with radium. *Ann. Surg.*, 92: 1007-1013, 1930.  
 TALBOT, H. S. Acute suppurative parotitis. *Am. Jour. Surg.*, 25: 267-276, 1934.





# WENS

FRANK N. DEALY, M.D., F.A.C.S.

Director of Surgery, Queens General Hospital; Attending Surgeon, Mary Immaculate Hospital

JAMAICA, N. Y.

THE lowly though frequently conspicuous "wen," or sebaceous cyst, has received scant consideration in the American literature for what are presumably obvious reasons. As humble as Uriah Heep, it can nevertheless often be as irritating as that famous character, and an effort further to expose it is therefore, we hope, justified.

In order perhaps, to get a clearer understanding of sebaceous cysts, it would be well to recall briefly the structures comprising the skin itself. First we have the epidermis with its corneal, granular and prickle layers, and directly beneath this the corium, derma or true skin composed of a thick layer of fibrous and elastic tissue and merging below with the fatty subcutaneous tissue with its blood vessels, nerve fibers, special nerve endings and lymphatics. Finally, we have the appendages of the skin consisting of the hair, nails, sweat glands and sebaceous glands. These various structures are well seen in Figure 1, a unique photomicrograph of the scalp, unique in the fact that it was taken not from normal scalp, but from scalp tissue found within a dermoid cyst of the ovary.

The sebaceous glands themselves, about as numerous as the sweat glands, arise in the corium, beginning at about the sixth month of embryonic life as lateral off-shoots from the rudimentary hair bulbs. As they gradually develop, small, fat granules appear in the central cells, sacculations form, and the gland becomes branched or lobulated. A basal layer of cuboidal cells develops which is continuous with the basal layer of the epidermis and the hair follicle and these in turn give rise to larger central cuboidal cells which develop fatty changes. These cells as they increase in size and number finally rupture and discharge

their fatty contents into the lumen of the gland, new cells from the active proliferating basal layer being supplied to take their place. The sebaceous or oil glands are thus seen to be usually, though not always, closely associated with a hair follicle into which their ducts as a rule empty. There may be as many as two to five glands emptying into each follicle, but some of the glands, especially about the nipples, genitals and lips, open directly on the surface of the skin independently of the hair follicle, and still others usually of a large size, open on the surface of the skin in conjunction with the lanugo hairs, the downy hairs occurring on the forehead, ears and trunk.

The sebaceous glands then, occur in the corium on all parts of the body except the palms, soles and terminal phalanges. They are lined by epithelium continuous with that of a hair follicle or the epidermis itself, and through their ducts discharge their fatty contents either for the most part into the hair follicles, or directly on to the surface of the skin.

If the duct becomes obstructed from dirt from without, from inspissated contents or as the result of inflammation, a cyst will form from the gradual accumulation of the odorous glandular contents within the gland itself and the distention of its walls, for a sebaceous cyst is of course, a retention cyst.

A cyst formed in this way by an accumulation of contents within the body of the gland itself is what really should be known as a sebaceous cyst. Broders however, believes, as Angrist has also pointed out, that many times cysts form within the duct rather than the body of the gland and that such cysts, often regarded as sebaceous cysts, are in reality epidermoids or kera-

tomas. In contradistinction to true sebaceous cysts, the keratomas contain a non-fatty material, odorless, unless infection is present, made up of layer upon layer of keratin originating from the epithelium lining the duct of the gland.

Sebaceous cysts, usually small, though sometimes as much as 2 inches in diameter, may occur anywhere on the surface of the body where sebaceous glands exist. As a matter of fact however, they are rare below the waist line though occasionally occur in the skin of the scrotum. They are commonest about the scalp and face, behind the ear, in the eyebrow or in the skin from which the beard grows. Often single, but especially in the scalp or scrotum frequently multiple, they occur also on the neck, shoulders and back. They are most frequently seen in individuals who have reached middle age.

They are usually painless, rounded or globular masses, not lobulated, pinkish in color, somewhat firm and elastic, though sometimes soft or even doughy, movable with the skin over the deeper structures but always attached at one point to the skin itself. This of course, is at the site of the opening of the duct into the hair follicle or on the surface of the skin and on close inspection at this point, may often be seen as a black speck which is the occluded or obstructed duct. Because of this point of attachment, the skin, especially with small cysts, cannot be moved over them, a fact which helps to differentiate sebaceous cysts from others, such as dermoids, which are of different origin. The cysts first grow within the skin itself, but as they increase in size, spread out into the underlying areolar tissue so that in large cysts the skin may be movable upon them at all points except at the central point of attachment.

As the cysts grow, the epithelial lining by a multiplication of its cells is likewise increased. These cells, gradually cast off in a state of fatty degeneration, together with fatty granules and cholesterol crystals, go to make up the contents of the cyst, in the smaller ones somewhat semi-solid or pasty in consistency, but in the larger ones usually

more fluid, the capsule meantime becoming more or less fibrous. They grow rapidly at times but often have a dormant period



FIG. 1. Scalp tissue taken from wall of a dermoid cyst of the ovary; A, duct of sebaceous gland; B, sebaceous gland; C, hair follicle; D, hair shaft; E, cyst of duct, epidermoid, with keratin layer; F, free border of the scalp surface toward cavity.

when they do not seem to grow at all, later again increasing in size. As they gradually enlarge, the overlying hair, noticeable in the scalp, becomes thinned out by pressure until it may completely disappear, and the skin itself may become irritated and inflamed or may even ulcerate as a malignant ulcer. The cysts themselves, especially those behind the ear or on the face, frequently become inflamed and often suppurate, discharging their contents externally, only as the inflammation subsides, to fill up again unless completely removed.

With the presence of such a cyst, with a history of slow growth and with perhaps periods of inflammation or suppuration, the diagnosis of sebaceous cyst is usually a simple matter. Confusion may nevertheless exist as to whether we are dealing with an ordinary wen, or perhaps with a dermoid or other growth.

Dermoids, however, are congenital and therefore may become apparent in childhood as well as in adult life, whereas wens are rare in childhood and usually occur in

middle age. Dermoids moreover, usually occur at points of fusion, and are therefore found chiefly about the inner or outer

protuberance. Dermoids also are usually covered by normal, freely movable skin and are not attached to the skin at one point,

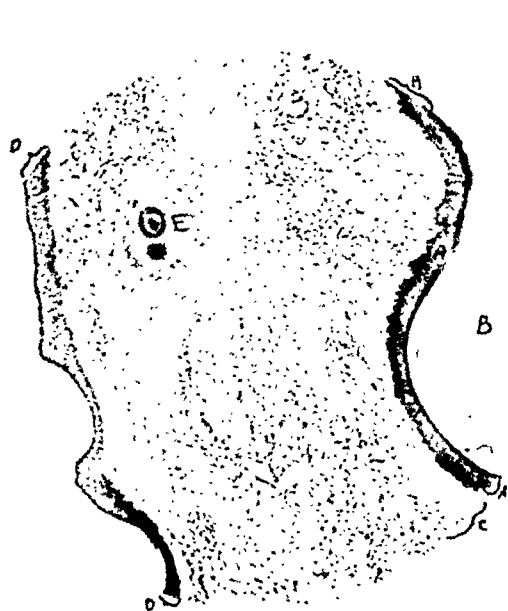


FIG. 2A. Low power photomicrograph of an epidermoid cyst with keratinizing squamous epithelial lining. A, epithelial lining (compare with Fig. 3A); B, cavity; C, connective tissue wall; D, overlying skin; E, hair follicle.



FIG. 2B. High power photomicrograph of epidermoid cyst; A, keratinizing epithelial lining (contrast with Fig. 3B); B, keratin content; C, connective tissue wall; D, stratum granulosum.



FIG. 3A. Low power photomicrograph of lining of sebaceous cyst. A, epithelial lining; B, sebaceous content; C, connective tissue wall; D, sebaceous gland.

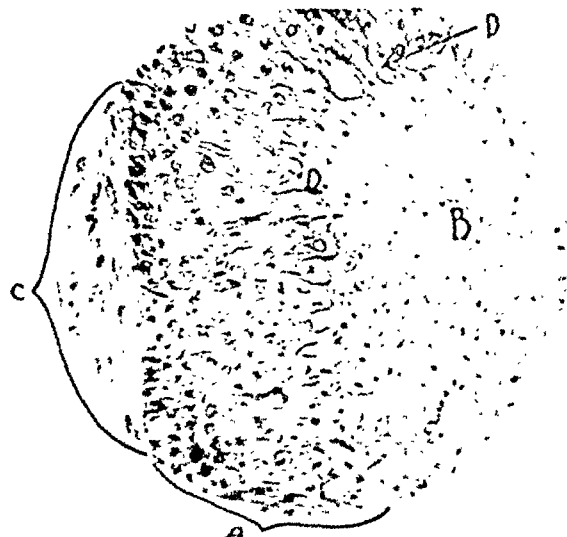


FIG. 3B. High power photomicrograph of lining of sebaceous cyst. A, epithelial lining; B, sebaceous content; C, connective tissue wall; D, large vacuolated cells resembling foam cells of xanthoma.

angles of the orbit, in the upper eyelid, or in front of or behind the ear, in the region of the anterior fontanelle or the occipital

as are the sebaceous cysts. Dermoids, however, are invariably attached at their base to the deep fascia or periosteum or to the

perichondrium of the ear and hence are not freely movable over the underlying structures and cannot slide over them as wens do. The sacs of dermoids become thicker at the base and if they contain hairs or other structures characteristic of dermoids, the diagnosis is apparent. Their contents moreover, are free from the rancid odor so peculiar to the sebaceous cysts.

Lipomas are usually distinctly lobular; sebaceous adenomas are rare and are usually a solid mass with a very thin covering of skin. So called "cirroid aneurysms," consisting of tortuous, dilated, pulsating vessels, are characterized by the usual complaint of "rushing noises" in the head and by their resemblance on palpation to a "bag of worms." Plexiform neuromas, usually affecting branches of the trigeminal nerve, are diffuse, soft masses in which separate cords can be readily palpated.

Sebaceous cysts especially when they ulcerate, frequently resemble epitheliomas, and in fact, this subject should not be dismissed without calling attention to the

up of prickle cells and less frequently of basal cells, grow into the cyst from the inner aspect of the wall itself and do not

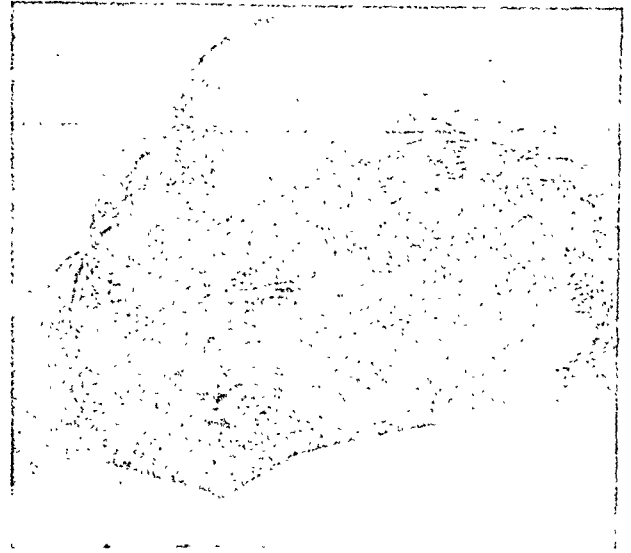


FIG. 4. Sebaceous cyst of a scalp in a woman sixty years of age; duration for forty-five years.

early invade the surrounding tissues. Ricker and Schwalbe reviewed the literature up to 1914 and found 43 cases of sebaceous cysts in which carcinoma had developed in the

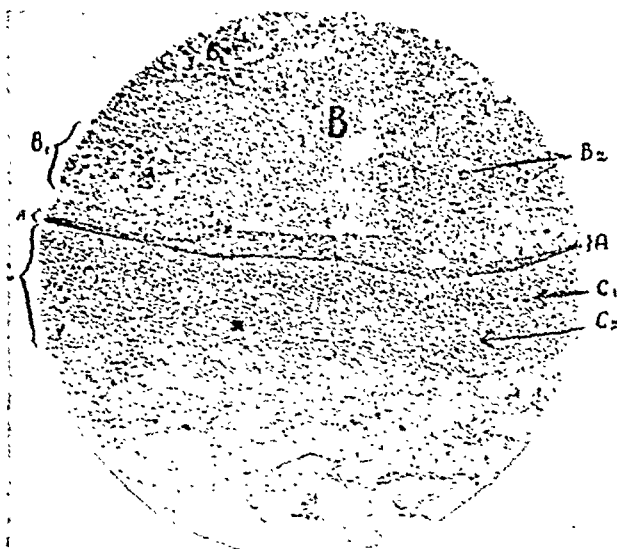


FIG. 5. Sebaceous cyst altered by chronic inflammation with granulation tissue organization of contents and wall; A, epithelial lining; B, organizing contents with B<sub>1</sub>, group of foreign body giant cells; B<sub>2</sub>, vascularization; C, connection tissue wall with C<sub>1</sub>, foreign body giant cells and C<sub>2</sub>, other inflammatory cells.

possibility of malignancy developing within the cyst itself, especially if ulceration is present. These epitheliomas, usually of the squamous cell type but occasionally made



FIG. 6. Dermoid cyst of eyelid; A, epithelial lining; B, hair follicle; B<sub>1</sub>, hair shaft; C, organizing tissue with giant cells.

cyst walls. In 17 of these ulceration was present. In a more recent report among 236 cases at the Mayo Clinic, Caylor found 12, or 3.4 per cent, in which malignancy occurred, ulceration being present in 4 patients. Bishop of the Steiner Cancer Clinic in Atlanta, in a series of 119 cases, found

malignancy in 9.2 per cent. Stone and Abbey of the New York Post-Graduate Medical School and Hospital, reported in 1935 an incidence of malignancy of 2.2 per cent in a series of 363 cases of sebaceous cyst studied. Malignancy was seen most frequently in cysts on the face and scalp, usually in patients over sixty years of age and about as often in one sex as in the other.

If a sebaceous cyst is completely removed, it does not of course, return and even if malignancy occurs and is recognized before the adjacent tissues are involved, recurrence is rare after wide and complete excision, for metastasis is infrequent.

Sebaceous cysts therefore, should be removed, not only because of the possibility of malignancy, but also because of their unsightly appearance and their susceptibility to inflammation and suppuration. A local anesthetic may be injected diamond-fashion about its base and if necessary beneath the cyst, or if the wall is not too thin it may be infiltrated between it and the surrounding skin forming a plane of cleavage and thus facilitating the enucleation. A straight incision may then be made directly over the cyst, or if the cyst is large and the skin redundant, an elliptical incision is made leaving the skin in the center attached to the cyst. Care, however, must be taken not to perforate the cyst as the enucleation is simpler if this accident can be avoided. With fine, curved scissors the skin edges are then separated exposing the cyst wall itself. With an elevator used for the submucous resection of the nasal septum, the sac can usually be readily enucleated, after which with the application of a little pressure to control oozing and the insertion of the necessary interrupted sutures or clips, a dry dressing is applied. If the sac is accidentally opened, this does not mean infection of the wound, unless suppuration already exists, but care must be taken under such circumstances to remove the entire cyst or recurrence will take place. If suppuration is actively present, it is wiser to incise and drain and not until the infection has later subsided, to remove the sac.

If malignancy is present or suspected, wide excision through normal tissue is, of course, essential. No attempt should be made to shell out the cyst and any incision into the growth during its removal should be unerringly avoided. Finally, every sebaceous cyst, innocent as it may appear, should be subjected to competent examination, microscopic if necessary, and if malignant changes are found, its removal should be followed by irradiation.

#### SUMMARY

1. The normal histology of the sebaceous glands and of other structures of the skin is first discussed.
2. The development of sebaceous cysts with their usual clinical manifestations is described.
3. The differential diagnosis between sebaceous cysts, keratomas or epidermoids, dermoids and other growths is discussed.
4. The possibility of malignant degeneration occurring in sebaceous cysts is stressed.
5. The treatment for sebaceous cysts is outlined.

In connection with the preparation of this paper, I wish to express my appreciation for the excellent work done by Mr. J. F. Rendich of the Department of Photography, for the ready assistance of Dr. Wm. J. Hoffman, Director of the Tumor Clinic, and for the ever to be relied upon cooperative spirit of Dr. Angrist, Pathologist, all of the Queens General Hospital, Jamaica, New York.

#### REFERENCES

- BUXTON. *Jour. Cutan. and Genito-Urin. Dis.*, 1901.  
 CHRISTOPHER. *Textbook of Surgery*. Phila., W. B. Saunders & Co.  
 CLARKE. *Ann. Surg.*, 1904.  
 ELLER. *The Practitioner's Library of Medicine and Surgery*, Vol. x, 1936. New York, D. Appleton-Century Co.  
 GREEN. *Arch. Ophth.*, 2: 145-151, 1922.  
 HAVENS. *Surg. Clin. N. Am.*, 15: 1227-1232, 1935.  
 KLEINSCHMIDT. *Deutsch. med. Wchnschr.*, 57: 1931.  
 STONE and ABBEY. *Arch. Dermat. and Syph.*, 31: 512-515, 1935.  
 SUTTON and SUTTON. *Diseases of the Skin*. Ed. 9. St. Louis, C. V. Mosby.  
 VAN BEUREN. *J. A. M. A.*, 66: 111, 1916.  
 WARING. *Virginia Med. Month.*, 59: 607-608, 1933.  
 WIGGLESWORTH. *Boston Med. and Surg. Jour.*, 7244 and and B.P. 698 (March) 1875.

# MOLES, WARTS AND KELOIDS\*

JOSEPH L. MORSE, M.D.

Assistant in Dermatology and Syphilology, New York Post-Graduate Medical School and Hospital, Columbia University; Attending Dermatologist and Syphilologist to the New York Skin and Cancer Unit of the New York Post-Graduate Medical School and Hospital, O. P. D.; Adjunct Dermatologist, Hospital for Joint Diseases

NEW YORK CITY

## MOLES

**M**OLES are classified in dermatology as pigmented nevi. They are accumulations of pigment in the skin with or without other skin changes, and are of congenital origin, but may not be visible at birth. They vary in color from a pale yellow or light brown to a bluish black, and may be single or multiple, varying in size and shape. They occur on any part of the skin surface and there is probably no adult who hasn't at least one mole of some kind.

There are several theories as to the origin of moles and at present the consensus of opinion is they are of epithelial origin. The melanoblasts or melanin forming cells produce pigment. They are in the basal layer of the epidermis but in a mole they migrate into the corium. Here they may still produce melanin, although the mole itself, after a period of growth, usually remains quiescent and becomes fibrotic. A mole presents a rather characteristic histopathology in that it contains groups of "nevus cells" in the corium with increased pigment in the basal layer. The nevus cell is a large, round or oval cell with large, vesicular-like, deeply staining nucleus. It may or may not contain pigment. Malignancy in a mole is carcinoma and not sarcoma. The exception to this is malignant development of the so-called "blue nevus" which is of mesodermal origin and becomes a nevosarcoma. The blue nevus is not included among the moles as it is really a mongolian spot that has persisted in an unusual location.

The subject of moles has for years been overlooked and little understood by the general physician and surgeon. Now that we have been made so cancer-conscious, the tendency has been to the other extreme and moles have become the cause of a good deal of controversy. In the minds of many, both physicians and laity, every mole is a dangerous lesion and should not be treated, destroyed or excised unless absolutely necessary because of the possibility of malignant development. Dermatologists, as a group, know this opinion to be most extreme and it is their duty to correct this widespread confusion. Had the dermatologist, rather than the surgeon, been more active in this phase of the cancer program from its inception, the idea of all moles being precancerous lesions might not have become so prevalent. It is important that the medical profession generally should get together on this subject and be of one mind as far as possible. The dermatologist advises the patient his mole may be removed without the slightest danger, only to have the patient say his family physician or some other specialist has emphatically told him never to have it touched. This causes a lack of confidence which is sure to hinder the progress and success of any program.

It is agreed that some moles have an element of potential malignancy, but it may also be stated that the common mole, especially if it has hair, rarely becomes malignant even when irritated. This is borne out by the experience of many outstanding dermatologists, who for years have been removing moles of various kinds

\* From the Department of Dermatology and Syphilology, New York Post-Graduate Medical School, Columbia University, Dr. George Miller MacKee, Director.

and have not seen one become malignant. The general pathologist may, on rare occasions, see malignancy in a "mole," without having examined the original lesion or knowing just what type it was to begin with, and get to believe all moles are dangerous. It is the black, blue-black or slate-colored mole, which is smooth and shiny and has no hair, the so-called melanotic mole that is dangerous and becomes the highly malignant melanocarcinoma. This is the type that has probably caused the confusion and controversy.

That brings us to the question should moles in general be removed; which moles must be treated; and which should be left alone? Specific treatment will be elaborated later when the various type of moles are discussed. As was stated, it is absolutely safe to remove any ordinary pigmented mole, especially if it contains hair. However, as a rule, they should only be removed either for a cosmetic reason or because they happen to be located where they may be constantly irritated, as in a man's bearded region, etc. It is always important in these benign lesions to keep in mind that the therapeutic end-result should be an improvement cosmetically over the original lesion. Some moles, especially in places exposed to trauma or irritation, may show signs of increasing growth and or pigmentation. These should be removed. Increased vascularity and bleeding or ulceration are always a danger signal and should be considered valid reason for treatment. However, that does not usually mean radical surgical excision with intensive x-ray or radium therapy. As irritation may cause malignant development, it surely is sensible and good preventive medicine to remove these growths while they are benign, especially if they are disfiguring. The black, blue-black or slate-colored mole is always a serious problem. If it is quiescent and not being irritated or liable to be traumatized, it is best left alone and watched. Should it show signs of activity, the combined opinion of a dermatologist and a surgeon should, if possible, be obtained and the

lesion widely and deeply removed. Naturally one always wonders whether it might not be better to excise these potentially very malignant moles when they are quiescent and not wait until they do become active. This would surely be better cancer prevention, although some say it is wiser to "let a sleeping dog alone."

For the consideration of specific therapy, moles may be classified into many types, depending on their individual characteristics and variations. The following is an arbitrary clinical classification adopted for the purpose of this paper:

1. Pigmented macules (nevus spilus);
2. Fibromatous "white" mole (probably fibroma);
3. Hairy mole (nevus pilosus);
4. Black and blue-black mole (melanoma);
5. Warty mole (nevus verrucosus).

#### TREATMENT

There is no uniform method of treatment for moles as each type presents an individual therapeutic problem and one should use the method that in his experience will give the most thorough removal with the best cosmetic result. The particular method will thus vary with individual men. I shall give the procedure in the various types that has given me the best results. The modalities used are electrodesiccation and electrocoagulation, electrocautery, electrolysis, solid carbon dioxide, caustics such as trichloroacetic acid, and surgery, either with the electrical cutting current or scalpel. I always favor the method, if possible, that does not require many repeated treatments. X-rays and radium are mentioned only to be condemned as they must be given in erythema doses to be of any value, and surely benign lesions should not be subjected to erythema doses of irradiation, with their possible sequels.

1. *Pigmented Macules.* These flat, non-hairy spots or patches vary in color from a pale, yellowish brown to a dark brown and may be single or multiple. They need only

be treated for cosmetic reasons when they are unsightly. They are absolutely innocuous. The small areas can easily be removed by electrodesiccation under local procaine anesthesia. A very mild cold spark is used and the desiccation is very superficial. The desiccated area is then removed with a dull skin curette and the base mildly desiccated, leaving a superficial, dry crust. If, in a week or two, after the crust falls off, there is still some pigment left, the procedure may be carefully repeated where it is necessary. In large patches the area may have to be treated in divided portions. Solid carbon dioxide may be used in the large patches but it cannot be as easily controlled and requires several repeated treatments. Trichloroacetic acid (U.S.P.) should be mentioned in the treatment of the smaller spots. The acid is applied with a moist cotton applicator, being careful that it is not running wet and does not get on normal skin. To make sure, vaseline may be applied around the pigmented area. As soon as the area turns white, it is neutralized with tap water by applying dripping wet pledgets of cotton. A scab is formed and falls off in about ten days. This may have to be repeated and if one is careful almost no scarring is obtained.

2. *Fibromatous Moles.* These are very slightly or not at all pigmented, and usually do not contain hair. Microscopically they are really fibromas, and it is a question whether they should be included in the classification of moles. They are most common on the face, but on the back, in the axilla and groins, they are usually pedunculated. Electrodesiccation or cautery under procaine is the method of choice, being careful not to go too deeply. It is always better to do too little rather than too much, thereby preventing a depressed, pitted scar. After the lesion is desiccated, it is cut down almost to the level of the skin with a fine pair of scissors. Then the base is again mildly desiccated. If after the crust falls off the lesion is still raised above the level of the skin, it is again very superficially desiccated. If it has hairs in it, these may

first be removed by electrolysis, and this at times causes disappearance of the mole.

The procedure with electrocautery is similar to desiccation. A flat electrode is used and the mole is seared down to the level of the skin, being careful not to do too much. Some men favor electrolysis, using the negative electrode and a current of 2 to 3 ma. The growth is transfixed in several directions parallel to the skin. After the crust falls off the treatment is repeated and in this way the lesion is "shaved" down flat to the skin. However, the method is inferior to desiccation because it requires more treatments, takes a longer time and is surely more irritating.

These growths may be removed by scalpel but it is not necessary and the cosmetic results are not as good. With the scalpel you get a linear scar, larger than the original lesion; the scar may be wide and may become keloidal. As for the pedunculated type, they are easily removed by grasping the lesion with a forceps and snipping it off at the base with a small, sharp scissors, being careful not to include normal skin, and then superficially and mildly desiccating the base. This is best done under local procaine anesthesia.

3. *Hairy Moles.* These vary in color from a very light to a dark, almost blackish brown. They are usually small in size and occur most often on the face. However, they may be present on any part of the skin and at times are so extensive as to involve large portions of the body. This is seen in the so-called "bathing-trunk" type of hairy nevus. In the small growths, it is always best to first remove the hairs by electrolysis. This at times may also cause a disappearance of the mole. If there is still some of the lesion left, it is removed by desiccation or electrolysis. However, when there are very many hairs in a small sized mole, especially if it is very dark brown in color, I do not attempt to remove the hairs by electrolysis because of the irritation and the danger of scarring. Here it is best to desiccate the lesion as if there were no hairs in it, using the same method that was de-



scribed in the removal of the fibromatous "white" mole. Later when the mole itself is gone, the hairs may be removed by electrolysis. In the larger sized hairy moles solid carbon dioxide is the treatment of choice, and if one has the patience, using repeated small doses over a period of many months, a very nice result can be obtained without too much scarring. If they are not too large, they may be removed by plastic surgery. This method when successful is surely much faster but it is a problem for the surgeon to decide in the individual case. When one thinks of the many dark brown, hairy moles that have been treated by solid carbon dioxide, with its repeated irritation over a period of many months, without causing carcinomatous changes, it is readily seen that moles have a very low potentiality for malignancy.

4. *Black and Blue-black Moles.* Although the term melanoma is given to all kinds of pigmented moles, it seems best to reserve this name for the blue-black or slaty colored mole. This is the highly dangerous type and is always a serious therapeutic problem. It is smooth, has no hair and is usually more or less raised above the skin. Most dermatologists are of the opinion they should be left alone when there are no signs of activity and they are in locations not exposed to trauma or irritation. However, they have such a dangerous potentiality for malignancy and are so deadly when cancer does develop, it might be better to remove them when they are inactive if they are situated where they may be easily irritated. Never treat this type with any irritating form of therapy. X-rays and radium have been used, but as nevus cells are highly radioresistant it requires massive doses which may lead to undesirable sequels. If the lesion is inactive and one decides to leave it alone, the patient should be watched and should be cautioned to immediately report any signs of activity. When the lesion is active and surgery is indicated and decided upon, the excision must and should be very wide and very deep down to fat, in a cone shaped

manner, the lesion itself being the apex. Some use the high frequency cutting current instead of the scalpel because of its supposedly lessened danger of metastasis. However, better and quicker healing is obtained following scalpel surgery. If microscopic examination shows melanocarcinoma, intensive doses of filtered x-rays or radium should be immediately given. Some radiotherapeutists advise this be done preceding excision and it might be just as well to do so.

5. *Warty Moles.* This type may occur anywhere on the skin surface. They are usually dark brown in color, warty in appearance and as a general rule do not contain hair. In size they vary greatly and may be so extensive as to cover a large portion of the body. In some instances, they are arranged in unilateral streaks and bands and are called linear nevi (nevus unius lateralis). The warty moles are best removed by electrodesiccation or coagulation under local anesthesia. Following coagulation, the area is thoroughly curetted. After bleeding is stopped with pressure, the base is mildly desiccated leaving a dry crust. This may be covered by a bland ointment such as boric acid and the dressing changed daily. The wound heals in a few weeks usually with little scarring. Very extensive areas may require several operations for entire removal. However, if possible and the resultant wound not too large, it is best to do it all at once. Excision by scalpel is very seldom necessary.

In the group of verrucous nevi, the so-called nevoid keratoses are often included. Although clinically they simulate seborrheic keratoses, they differ from these lesions in that they occur in much younger individuals, there is no accompanying seborrhea and they are often familial. They are small, dark in color, slightly raised and often numerous. If for cosmetic reasons the patient wishes them removed, it is best done by electrodesiccation followed by curettage. Several individual lesions may be removed at a sitting. The cosmetic result is usually excellent.

## WARTS

Warts or verrucae are benign epidermal new growths formed by hypertrophy of the papillae. They are probably infectious and are thought to be caused by a filterable virus. They are auto-inoculable and can be transferred from one person to another by inoculation.

They are divided into four clinical varieties:

1. *Verruca vulgaris*, the familiar common wart;
2. *Verruca plana juvenilis*, the flat "juvenile" wart;
3. *Verruca plantaris*, the plantar wart;
4. *Verruca acuminata*, the "venereal" wart.

1. *Verruca Vulgaris*. There are several types of the common wart, such as the digitate and filiform wart, and their names describe them very well. The so-called seborrheic and senile warts are not placed among the verruca. They are classified as keratoses, have a different histopathology and are precancerous lesions. The ordinary common wart is seen usually in children and most frequently on the hands and fingers. However, the different types may occur at all ages and any place on the skin or mucous membrane. There may be one or several in number and at times be very numerous. The filiform variety is usually seen on the neck and eyelids; the digitate type on the scalp and face.

In discussing the treatment of warts, it may be best to preface any remarks by saying they may disappear spontaneously, may easily respond to any kind of treatment, or be so recalcitrant as to almost defy any method of therapy. The fact that warts do disappear spontaneously gave rise to psychotherapy or "suggestion" treatment, and several dermatologists have had a marked degree of success with this method. The patient is made to believe some treatment is really being used. The lesions themselves are painted with any colored liquid, and may even be given a placebo treatment with some electrical modality, whatever it

may be. The advocates of this method stress the value of impressing the patient that the warts are sure to disappear. In certain instances, when simple methods fail, or because surgical procedures cannot be used, psychotherapy should be kept in mind. At times slight trauma of any kind will cause a wart to disappear, so that one may give the mildest kind of treatment and get a good result. As for prognosis, no matter how stubborn warts may be, with persistence and therapeutic ingenuity they can always be cured.

The various methods of treatment for warts in general are electrodesiccation, cautery, electrolysis, curettage, solid carbon dioxide, caustics, x-rays and radium. There are also internal remedies such as protiodide of mercury, bismuth salicylate in oil, and sulpharsphenamine. I prefer desiccation, when possible, or irradiation, depending on the age of the patient, the location and number of warts. If there are one or a few lesions, and the patient will allow local procaine anesthesia, electrodesiccation is the surest and quickest way to get rid of them. There is always the possibility of scarring, but if it is not overdone usually gives an excellent cosmetic result. Using a very mild current, the needle is inserted into the wart several times, being careful not to go too deeply. The dehydrated wart is then lifted up and cut away at its base with a sharp pointed scissors, making sure the "core" is removed. The rough edges are trimmed and the bleeding is stopped by gauze pressure. The base is then very mildly and superficially desiccated, leaving a dry scab. This is dressed with boric acid ointment or vaseline, and falls off in a week or so. If there are many warts, several may be done at a time until all are removed. Even with thorough removal, warts do recur, and it is best to warn patients or their parents of this possibility.

X-rays and radium give a high percentage of cures in warts, and because of the absence of pain and the ease of application, many patients prefer taking the chance and

trying it. Unfiltered x-rays or the beta rays of radium are used. Depending on the size and depth of the wart, three-fourths to two skin units (erythema doses) are given, shielding the lesion very closely. If there are many warts, irradiation is difficult because of the time element, but it can be done on successive days, treating several each day. Care must be taken not to overlap if the warts are close together. Depending on the dose, the treatment may be repeated in a month or longer, if there is an improvement. X-rays or radium are particularly of value for warts occurring at the side and under the nails, because they are so difficult to remove surgically. Should there happen to be many warts closely aggregated in one area, as digitate warts in the bearded regions, unfiltered x-rays in fractional doses may be tried, and at times are successful. It is in these cases that recurrences are common following electrodesiccation. Here the internal remedies may also be used, either in conjunction with the x-rays or alone. Of these I prefer insoluble bismuth salicylate in oil, 0.03 to 0.12 gm., given intramuscularly once a week for as long as twelve weeks. Sulpharsphenamine, 0.2 to 0.4 gm. in 2 c.c. of water, intramuscularly, has given excellent results in some cases, but it is a dangerous drug, is quite painful, and for warts the much less dangerous bismuth is to be favored. In the line of psychotherapy, sterile distilled water, 1 c.c., has also been used intramuscularly with almost as good results as bismuth or sulpharsphenamine. The other forms of therapy as electrolysis, solid carbon dioxide, caustics, etc., are easily applied but are painful, require repeated treatment and usually do not remove the wart.

2. *Verruca Plana Juvencilis*. These small, flat, skin colored or light yellow lesions occur chiefly on the face or backs of the hands. They are smooth and very slightly raised but not warty to the touch. Although usually seen in children they do occur in adults, and are generally multiple in number. Protiodide of mercury pills,

$\frac{1}{8}$  to  $\frac{1}{4}$  grain three times a day, should always be tried for several weeks as they seem to be effective at times. Bismuth salicylate and sulpharsphenamine have also been used with success. Along with these internal remedies, lotio alba in various strengths, or ammoniated mercury ointment 3 to 5 per cent, is used locally. Very often unfiltered, fractional doses of x-rays, giving  $\frac{1}{4}$  of a unit once a week, are successful. When these methods fail or when the patient, usually an adult, wishes results as quickly as possible, electrodesiccation followed by curettage is the method of choice. Each lesion, without anesthesia, is mildly desiccated and then gently scraped off with a sharp skin curette. If done carefully, with a weak current, no scarring results, but recurrences are apt to follow. It is possible recurrences are due to the fact that some hardly discernible lesions are overlooked and it is therefore of value following desiccation to use lotio alba or preferably ammoniated mercury locally.

3. *Verruca Plantaris*. These warts occur on any part of the plantar surface of the foot and toes, but most frequently on the sole. They are single or multiple, and may be on one or both feet. At times they are quite painful. It is not difficult to differentiate them from calluses, which do not have a central core. The chiropodists and podiatrists call them "papilloma." Their method is to pare the lesion down and use various caustics; it is painful, requires several treatments and is seldom successful. The treatment of choice for plantar warts is irradiation or electrodesiccation. Unfiltered x-rays or the beta rays of radium are used, and are given in doses of one to two and one-half units, depending on the size of the wart and the age of the patient. Each wart is pared down with a sharp razor blade, before treatment, and very closely shielded. If there is an improvement, treatment may be repeated in a month or so depending on the dose. Quite often, shortly after x-ray treatment, the pain is alleviated. Should irradiation fail,

electrodesiccation is usually successful, although even careful, thorough removal may be followed by recurrences. The most difficult part of the procedure is the procaine anesthesia, especially in young children. When there are several or many warts in children a general anesthetic may have to be given. The plantar surface of the foot is very sensitive and one should try to procainize the area with one prick of the needle, using sufficient procaine to produce complete anesthesia. The desiccating needle is then inserted into the area several times, and the entire lesion is dehydrated. The wart is then lifted up and cut away with a sharp scissors, down to the fascia. The base is curetted and the edges of the wound are trimmed. After bleeding is stopped the entire area is mildly desiccated. The wound is dressed with borated vaseline and protected by a "bunion plaster" with a hole slightly larger than the area. The patient is told to favor the foot and not actually step on the wound, but should not be inconvenienced otherwise or be obliged to stay home. Infection rarely occurs and healing takes place in several weeks.

The internal remedies, such as bismuth, sulpharsphenamine and protiodide of mercury are less efficacious than in other warts. A simple method, which at times is successful, is paring the lesion and covering it with strong salicylic acid plasters. It takes a long time however, and if the wart is painful the patient wishes relief as quickly as possible. In fact, when a plantar wart is very tender I prefer electrodesiccation to x-rays because the wound is much less painful than the wart and the relief is immediate.

4. *Verruca Acuminata*. These "venereal" or "moist" warts occur on the mucous and mucocutaneous surfaces of the genitalia, genitocrural and anal regions. They are usually seen in adults, are multiple in number and often coalesce to form large, conglomerate, vegetating masses. In diagnosis they must not be confused with the flat, moist papules of syphilis or condylomata lata. When they are not too numerous each lesion may be desiccated

and curetted, which requires time and patience, and it may be necessary to use a general anesthetic. The large, conglomerate masses are removed by electrocoagulation and curettage, under local or general anesthesia. Following the operation, the area is kept clean with antiseptic solutions, such as weak potassium permanganate, and covered with borated vaseline. Recurrences should be watched for and immediately treated. If the patient does not wish operative procedures, x-rays should be used although I have had very little success with them in this variety of wart. The unfiltered rays are given either in weekly fractional doses or semi-intensive doses every two or three weeks. Meanwhile the area is treated locally with antiseptic wet dressings and dusting powders. The internal remedies have been of little value in the treatment of acuminate warts but they may be tried if necessary.

#### KELOIDS

Keloids are overgrowths of the fibrous connective tissue of the skin, developing at the site of an injury or scar. They differ from hypertrophic scars, which are also overgrowths of fibrous tissue and keloidal in appearance, but do not extend beyond the original line or area of injury as do keloids. Whereas keloids are always due to some inherent idiosyncrasy or tendency in certain people, hypertrophic scars may be due to tension on a wound. The surgeon and his method of surgery or skill cannot be blamed for the occurrence of a keloid. It has been noted that some people who have had a marked idiosyncrasy to keloid formation may in later years lose this tendency.

Two varieties of keloids are spoken of, the spontaneous or idiopathic form, and the one that arises in any ordinary scar. Most dermatologists do not accept the theory of spontaneous origin of a keloid. This type usually follows some slight, inconspicuous trauma of which the patient was not aware. In a person with an inherent tendency to keloid formation, squeezing a pimple, a

mosquito bite or any mild injury may result in a keloid. The colored skin is particularly inclined to keloid formation. They may be single or multiple, occur on any part of the skin and may be quite extensive. At times, especially following burns, there is a good deal of contraction with resultant deformity and disfigurement.

The treatment for keloid is irradiation or surgery combined with x-rays or radium. Any surgical procedure alone is fairly certain to result in another keloid, usually worse than the original growth. However, in patients who seem to have lost their tendency to keloid formation, surgery may be attempted. Some surgeons have devised special operations for keloids that are at times very successful. For young keloids, x-rays are the treatment of choice. The lesion is shielded closely and suberythema doses of unfiltered rays are given once a month. If the scar is very large, it can be treated in divided areas being careful not to overlap. In keloids that are quite raised, it is best to use filtered x-rays, also giving suberythema doses. When the scar is old and very thick, it requires many x-ray treatments for as long as a year or more and even then may not be successful. In these cases the combination of surgery and x-ray irradiation saves many months of treatment and usually gives excellent results. This is due to the fact that x-rays have a selective action on fibroblasts and young connective tissue cells but old fibrous tissue is radioresistant. Under local anesthesia the keloid is either excised with scalpel or the electric cutting current. If the scalpel is used and the wound is small it is closed with as few sutures as possible or with skin

clips. However, I prefer using the electric cutting current and leaving the wound open. In about three to five days, the area is given three-fourths of an erythema dose of unfiltered x-rays. This is repeated in three weeks and if there is the slightest sign of keloid formation following the second treatment, it is again repeated. If the wound is quite extensive, skin grafting may have to be done followed by x-rays. Large keloids may have to be removed in divided areas. If it is done at one time and the wound is too large to treat with x-rays at one exposure, the area must be carefully mapped out so as not to overlap. I do not feel it is of any value to give x-rays before or immediately following excision because they do not prevent keloid formation. With the combination of surgery and x-rays the resultant scar is usually flat, smooth and thin, and the cosmetic effect is very satisfactory.

#### SUMMARY

Moles, as a group, have a very slight tendency to malignant development. The black or blue-black mole is potentially very malignant and is a serious therapeutic problem.

The types of moles are described with the various methods of treatment for each type. It is perfectly safe to treat the ordinary mole.

The varieties of warts are described with the methods of treatment.

The treatment of keloids is discussed. As a rule they should not be excised. Treatment is either with x-rays or radium, or a combination of surgery and irradiation.



# BENIGN TUMORS OF BACK\*

RICHARD J. WEISKITTEL, M.D.

Professor of Orthopedics, and Associate Staff, Fracture Service, Good Samaritan Hospital

CINCINNATI, OHIO

THE back is the site of numerous benign tumors, many of which are also found elsewhere on the body. To classify these tumors which are peculiar to the body must necessarily conflict with tumors in general. As space is limited only a few of the more important of these will be considered, with their appropriate treatment.

## LIPOMAS

These are the most common connective tissue tumors and may arise from connective tissue as well as from adipose tissue. The "embryonic rest" theory gives a reasonable explanation of many lipomas starting in tissue which normally contains no fat.

Lipomas usually contain a fibrous capsule and are divided into lobules by fibrous septa. There are however diffuse forms which do not seem to have a definite capsule. The capsule and septum are very thin and delicate but following infection or irritation they may become greatly thickened. There has been no malignant form reported but they are true tumors for they are not reduced in size during the course of a general wasting disease.

Lipomas usually occur in most any part of the body in which there is adipose tissue. They are most frequently seen however in the subcutaneous fatty tissue of the shoulder and lower part of the back, and usually occur singly although they may be multiple. These tumors tend to become pediculated on the back where traction is exerted by their weight. They grow slowly as a rule but may vary from a stationary condition to a very active process. Sometimes they develop to an enormous size weighing as much as sixty to

seventy pounds. As a class they are probably the largest solid tumors. Ulcerations followed by infection, gangrene and calcareous degeneration frequently occur.

Because of deformity, ulceration and pain, surgical removal is always indicated. In the pediculated one it is quite essential to excise the entire base of the pedicle. In the nonpediculated type of moderate size, well encapsulated, an adequate way of excision consists in cutting completely through the tumor mass in the center of its greatest diameter. In the depth of the wound the two halves of the tumor may be grasped with forceps and shelled out individually. This can be accomplished in a very few seconds. When the fatty tumor is diffuse a careful dissection of the entire mass is necessary.

## SEBACEOUS CYSTS

Sebaceous cyst, *wens* or *atheroma*, are retention cysts caused by the obstruction of the duct of the sebaceous gland with the consequent accumulation of sebum and desquamated epithelium. The wall of the cyst is composed of connective tissue lined with secretory epithelium so that a cure is not affected unless all of the sac is removed. The secretion may be fluid, semisolid, cheesy or purulent, with or without a terrifically foul odor.

Broders and Wilson distinguish between sebaceous cysts and keratomas, both called *wens*. They state that "true" sebaceous cysts contain a fatty material which gives off a strong odor; keratomas, on the contrary, unless infected or badly degenerated are practically odorless. Many lesions diagnosed as sebaceous cysts or *wens* clinically, when examined microscopically are found to be made for the most part of

\* Surgical Department, DeCourcy Clinic.

keratin and not sebaceous material. There is considerable evidence to support the belief that these lesions are tumors that

First the line of incision is infiltrated, followed by an injection below the cyst at its base. In the larger wens it is advisable to



FIG. 1. Spina bifida.

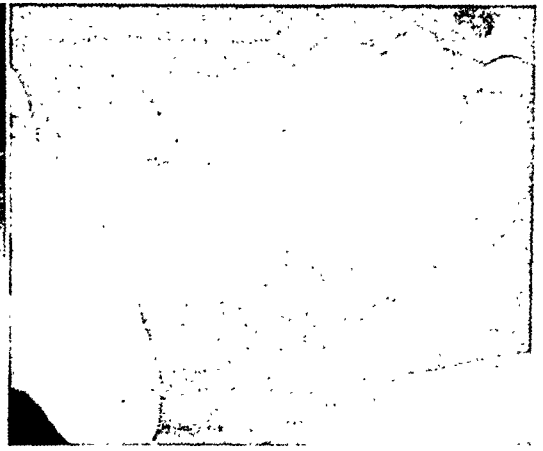


FIG. 2. Spina bifida.

arise in the ducts of the sebaceous gland rather than from the sebaceous gland proper. For such tumors they believe that keratoma is a more accurate term than sebaceous cyst.

On the dorsum of the trunk particularly the scapular and intrascapular regions, sebaceous cysts may assume a larger size than in other parts of the body. Regional distribution on the back of the trunk is approximately 7.78 per cent. In size these cysts vary from a millet seed to an egg or larger. They may be globular or hemispherical in shape with or without a recognizable duct opening. They may be single or multiple, movable or fixed. The skin over them is sometimes normal in color, smooth or white if distended, red if inflamed. The absence of lobulation and the fact that sebaceous material may be expressed from sebaceous cysts, help to differentiate them from lipomas. Dermoids are congenital, are usually deep seated and noticed early in life. Fibroma molluscum is a solid pediculated tumor and multiple.

All sebaceous cysts should be removed because of the possibility of malignancy. When these tumors are acutely inflamed it is considered best to incise and drain allowing the infection to subside before excision is undertaken. These tumors can be satisfactorily removed with local infiltration.

excise a section of the skin with the wen. After the skin incision the cyst may be removed intact by blunt dissection. Some of the smaller sebaceous cysts are quite hard. These may be removed merely by a small incision along its greater diameter. By pressing the index finger against the sides of the incision the entire cyst frequently shells out with its capsule. It is frequently possible to grasp the capsule of the tumors with hemostats and enucleate them from the wound even after accidentally opening the cyst.

#### DERMOIDS

A dermoid cyst is one of congenital origin occurring in one of the lines of embryonic closure of the skin. It may be apparent at birth or may not be noticed until some years afterward when its increase in size first attracts attention. Some dermoid cysts are made up of a single layer of epithelium with sebaceous contents in which hair is sometimes found.

Dermoid cysts containing teeth are quite rare. Fuller and Jagger reported a dermoid cyst containing teeth in the substance of the left erector spinal muscle at the level of the tenth and eleventh ribs. After excision the tumor mass was found to contain tufts of hair and sebaceous material with

two large teeth fixed to the lower edges of the eleventh rib.

If the attachment of the dermoid cyst to

ing of the sinus is generally in the midline between the tip of the coccyx and the anal canal and runs upward toward the lower



FIG. 3. Fibrosum molluscum in a twenty-two year old woman.

the deeper structures is slight its removal is almost as simple as the removal of a sebaceous cyst. Some dermoids have extensive deep attachments so that their removal is difficult.

*Postanal Dermoids (Sacrococcygeal, Pilonidal) Cysts and Sinuses.* These are encountered in the region of the sacrum and coccyx. These congenital malformations originate from faulty skin development. The predominant symptoms are due to infection with the pathological picture that of acute and chronic inflammation. Although present from birth no appreciable symptoms are noticed until adult life.

Postanal dermoids may contain hair and most frequently communicate with the skin by a small fistula or sinus. The open-

end of the sacrum and coccyx. When the opening is not in the midline there is generally a well marked depression at this point and the existing sinus or sinuses are the result of previous operations or secondary infection in the cyst. In some cases this sinus may have its orifice very close to the anus and will simulate a fistula-in-ano. In others the orifice will be much higher, or there may be multiple openings which communicate with a cyst-like cavity. The reason for the inability to find hair in many postanal dermoids is probably due to the fact that long continued suppuration has destroyed the hair follicles.

Incision and drainage, curettement and cauterization are inadequate. Complete excision is required, and because of the fact



that hair follicles and sebaceous glands opening out of the sinus may be a little distance from the surrounding fat this



FIG. 4. Fibrosum mollusum in a twenty-two year old woman.

excision should be made with ample margin on all sides of the tract. Due to the presence of infection in the majority of these cases local or spinal or caudal anesthesia is definitely contraindicated.

In a series of 121 cases at the DeCourcy Clinic during the past five years, wide excision under general anesthesia was performed in all cases. In the presence of marked infection, the Bovie electrosurgical knife has been employed. With the use of the electrocautery unit less bleeding is encountered and the spread of infection is minimized. Since the cyst wall in these cases is adherent frequently to the fascia over the sacrum it has been found necessary to excise this structure in some cases. Of the 121, 26 had been operated previous to admission. All cases have been closed with mattress sutures of silkworm gut with as much obliteration of the blind space as

possible, the skin being further closed with interlocking dermal. Many cases in which free pus was not encountered were closed without drainage with primary healing of the wound. The majority were drained and after removal of the rubber tissue drain eight days later, the wound was irrigated with Dakin's solution until complete closure occurred.

#### FIBROMAS

*Fibromas* are connective tissue new growths and may occur singly as hard or soft tumors varying in size and shape, or as multiple lesions, congenital or acquired and are often accompanied by pigmentation. On the back they are sometimes found singly as pendulous tumors of huge proportions or multiple in the condition known as fibrosum mollusum or Von Recklinghausen's disease. Fibromas are more firm in consistency than lipomas and frequently a combination of lipoma and fibroma, fibrolipoma, may occur.

#### MOLES (NEVUS)

One of the locations of occurrence of the pigmented mole is the dorsum of the trunk. The "nevus spilus" is a minute pigmented spot; the nevus verrucosus is a soft flat elevation which often grows to a warty excrescence; nevus pilosus includes hair; and nevus papularis is a papillary tumor.

Moles frequently undergo malignant change. When a pigmented nevus is in a situation where it is exposed to constant trauma, as on the back, it should be removed. The same applies to a pigmented mole which is definitely increasing in size. In general the darkly pigmented moles especially when covered by hair may in safety be allowed to remain. The bluish or slate colored smooth mole which is not appreciably elevated should be excised early or kept under careful observation. Such a lesion if irritated by constant trauma or by improper treatment may be the source of nevocarcinoma, one of the most rapidly fatal types of malignancy. Electrosurgical excision is a most satisfactory method of

removing moles. When local anesthesia is employed injection should be made a good margin from the seat of the tumor.

#### KELOID

True keloids are connective tissue new growths of the corium characterized by nodules, plaques or tumors of irregular shape, presenting a smooth or corrugated, whitish or reddish surface resembling a hypertrophied cicatrix.

The disease was first described by Alibert who named it on account of its peculiar claw-like appearance in some cases. It is difficult to distinguish between a true and spontaneous or idiopathic keloid and the false or spurious form which is in reality a hypertrophic scar. Hypertrophic scars are limited to the area of injury while true keloid spreads indefinitely without limitation. The common form consists of a central mass of varying proportions with claw-like prolongations extending from the periphery. The lesions vary in size from that of a small pea to that of the palm or larger. When developed to an extreme degree lobular and tumor-like growths are often seen. The most frequent site of the disease is the anterior surface of the chest. It is also observed on the back in the scapular and intrascapular regions. Surgical removal followed promptly by roentgen ray therapy gives the best results.

#### OSTEOMATA (EXOSTOSIS)

These benign overgrowths of bone rarely occur from the bony structure of the back. During the past three years we have encountered one such tumor mass. An osteoma, arising from the posterior superior iliac spine, was approximately 8 cms. in diameter. With chisel and rongeur the tumor mass was readily removed.

#### SPINA BIFIDA

Spina bifida is a congenital lesion characterized by failure of closure of one or more of the vertebral arches and in the ordinary form with herniation of the contents of the spinal canal. Two factors seem to be pres-

ent in the formation of this condition, namely, the arrest in the development of the vertebrae associated with incomplete separation of the neural tube from the skin and faulty cerebrospinal circulation (increased pressure of the cerebrospinal fluid).

The structures involved enter into the process in varying degrees. The simple form is a cleft of one or more vertebral arches with herniation of the meninges, or meningocele. The second degree contains definite neurological elements in the hernial sac or meningo-myelocele. The third, which is rare, is that in which the neurological elements form a part of the hernial sac and the fluid is contained in a dilatation of the central canal. In most instances the skin and the meninges are fused and the skin is so thin that it seems to be entirely lacking, the sac being a glistening transparent membrane of paper thinness.

An unusual form but one sometimes encountered is that in which there is a rounded, fatty or fibrous tumor often pedunculated protruding through a cleft but without any demonstrable meningeal sac. This may be the simplest form of spina bifida, one without meningeal involvement or it may represent the spontaneous intra-uterine cure of a small meningocele.

Spina bifida is one of the most serious of the congenital defects. If there are neurological elements involved it almost always means a greater or less degree of paralysis below the defect and as this paralysis is caused by involvement of nerve elements in the sac it is seldom if ever improved by surgical intervention. In considering indications for operation it must be remembered that spina bifida is a condition in which the patient has nothing to lose and everything to gain by operation even though a certain number of cases of successful operation later develop hydrocephalus. Early operation is indicated, that is, as soon as the general condition of the child permits. Spina bifida is most common in the lumbar region but may occur in the lumbosacral, cervical or dorsal regions of the spine. There is great varia-

tion in the size and shape of the sac. In some instances a large sac may be connected with the cerebrospinal space by a small opening, the whole pedicle being very small. In others there is a long wide opening into the neural canal, the spread-out cord lying in the bottom of a shallow trough. In the first instance the problem is simple and obvious but in the latter it is much more complex. Each case must be handled on its own merits. There must be attempted a reconstruction as well as possible of the normal dural sac.

The general method of surgical procedure now consists in excision of the excisable portion of the sac, with the return to the spinal canal of returnable portions and the protection of the gap by means of superimposed flaps of muscle and aponeurosis. Flaps of bone and plates are being abandoned.

*Spina bifida occulta* is a congenital malformation consisting of a cleft in one or more vertebrae without a meningeal sac showing on the dorsum of the body. *Spina bifida occulta* exists far more commonly than is realized and without any appreciable symptoms. It occurs most frequently in the lumbar region, and next in the lumbosacral region. Occasionally with

*spina bifida occulta* paralysis ensues from birth or occurs at a later date. The outstanding symptoms are loss of bladder or sphincter control, loss of sexual power, anesthesia of the feet, toe drop, etc. Treatment consists of exploratory laminectomy, with relief of pressure from whatever cause, on the delicate roots particularly those of the second sacral segment.

#### SUMMARY

A list of the most common benign lesions occurring on the back have been considered briefly with their treatment. This article is not meant to be an exhaustive treatise on the subject but rather a practical ready reference.

#### REFERENCES

- BICKHAM, Operative Surgery.  
BREIDENBACH, LESTER and WILSON, LYNN. Pilonidal cysts and sinuses. *Ann. Surg.*, 102: 455, 1935.  
BRODERS, A. C. and WILSON, E. *Surg. Cl. N. A.*, 10: 127, 1930.  
CHRISTOPHER, FREDERICK. *Minor Surgery*. Phila., W. B. Saunders Co.  
FOOTE, E. M. *Minor Surgery*, Ed. 3, New York, D. Appleton, 1912.  
FULLER, C. B. and JAGGER. *Brit. Jour. Radiology*, 32: 176, 1927.  
MINTER, WM. S., M.D. *Spinal Column and Cord*.  
ORMSBY, O. L. Lewis, *Surgical Diseases of Skin*. Hagerstown, Md., W. F. Prior Co.



# HEMORRHAGE FOLLOWING TONSILLECTOMY

MERVIN C. MYERSON, M.D.

Director of Otolaryngology, Kings County and Sea View Hospitals; Attending Otolaryngologist, Brooklyn Cancer Institute

NEW YORK

**H**EMORRHAGE is the most frequent and most feared complication of tonsillectomy and is the most important phase of tonsil operative work. In the early Christian era, Celsus<sup>1</sup> wrote of the removal of tonsils in his *De Re Medicina*. He spoke of "The proper remedies used to arrest hemorrhage." The writings of Paul of Aegina,<sup>12</sup> who lived in the seventh century, contain some interesting instructions regarding the control of hemorrhage following the tonsil operation. He wrote: "If any hemorrhage comes on we may use a tepid decoction of brambles, roses and myrtle leaves; or, if the blood flows copiously we must give for a gargle the juice of plantain and comfrey, copiously and the trochisk from amber and the Lemnian earth, dissolved in oxycrate." There have been occasional references to tonsil surgery and the use of the cautery and escharotics for the control of hemorrhage, through the centuries.

The popularity of the tonsil operation and the frequency of its performance kept pace with the improvement of the instruments and the techniques involved. Mackenzie<sup>5</sup> designed what can be called the forerunner of the present day guillotine when he modified the type of instrument originated by Physick<sup>13</sup> in 1827. It was not, however, until Whillis and Pybus<sup>19</sup> in England, and Sluder<sup>17</sup> in this country almost simultaneously brought forth their instruments and the simplified operations which went with them that the tonsil operation became tremendously popular. Both the skilled and the unskilled took it up and have been performing this operation in great numbers.

The popularity of the operation and the fact that it has been made available to anybody who had access to the instruments, regardless of his qualifications, are

probably the greatest considerations in the matter of postoperative hemorrhage, and many of the other complications which have been known to accompany tonsillectomy. Yet a certain number of hemorrhages which could be prevented are occurring daily. The occurrence of hemorrhage is embarrassing to the physician and distressing to the patient and his family. Many physicians have been maligned unjustly by the patient and his relatives because of this unfortunate occurrence. Patients come to us apparently healthy and cannot comprehend a serious complication.

Everything should be done to insure the patient against any form of complication following a tonsil operation. He should be examined by his physician before operation. Blood dyscrasias or general systemic conditions which might make the patient a risk should be sought. No patient should be operated upon whose bleeding habits are not carefully considered. Coagulation and bleeding times should be taken preoperatively wherever possible.

For many years a coagulation test has been performed routinely in most hospitals. The failure to use this test might prove embarrassing from a medicolegal standpoint, although it has been shown by Richards,<sup>14</sup> Hunt,<sup>5</sup> McKinney,<sup>10</sup> Jones<sup>6</sup> and others that this test is not reliable. Jones, who is in charge of an unusually large tonsil clinic, does not perform the coagulation test routinely. He says: "Many patients whose coagulation time is lengthened, do not bleed as much as those whose time is normal." Our experience with this test is in accord with that of the authors just mentioned.

It has recently been demonstrated that severe hemorrhage may follow any type of operation in an individual who is suffering from vitamin c deficiency. This deficiency

may be only moderate, but can create a mild scurvy.

Some bleeding must be expected with each tonsil operation. Such a thing as a bloodless operation does not apply to the operation as it is done today. It should be our aim to have no bleeding immediately after operation, or for several days following.

Very few well trained and experienced individuals have met with so serious an experience as death from hemorrhage. Today, in the hands of the well trained, with modern instruments and technique, death from hemorrhage following tonsillectomy does not occur. A good knowledge of the anatomy involved, together with an understanding of tonsil surgery, and the exercise of reasonable care, insures a minimum of trouble.

Severe hemorrhage occurs occasionally, but it occurs with little frequency in well organized hospital practice. As evidence of this, during the years 1931 to 1935 inclusive, 10,305 tonsillectomies were performed at the Kings County Hospital. Not a single death resulted from hemorrhage, although there was one death which was related to the anesthetic. An even more striking experience is that recorded by Jones.<sup>6</sup> In a series of 52,467 tonsillectomies there were no deaths directly due to hemorrhage. Martin<sup>9</sup> reported 14,690 tonsillectomies and no deaths. These statistics indicate that removal of tonsils and adenoids, when properly planned and executed by well trained and competent operators, carries very little risk. Certainly the danger of serious hemorrhage is held to a minimum.

The following table represents the number of operations and the severe hemorrhages which required treatment during three years:

| Year    | Operations | Severe Hemorrhages | Percentage |
|---------|------------|--------------------|------------|
| 1931    | 1159       | 11                 | .95        |
| 1932    | 1446       | 19                 | 1.31       |
| 1935    | 2193       | 39                 | 1.77       |
| Total.. | 4798       | 69                 | 1.44       |

Richards<sup>14</sup> recorded 6 serious hemorrhages in 500 operations, a percentage of 1.2, while Tilley<sup>18</sup> had 4 hemorrhages in 670 cases for an average of 0.6 per cent. In Martin's series the primary hemorrhages range between 0.35 and 0.77 per cent; in Jones' series the primary hemorrhages amounted to 3.25 per cent, while the secondary hemorrhages were 1.25 per cent.

That deaths have occurred and very likely still occur is indicated by the answers to the questionnaires which Hill<sup>4</sup> and Hanau Loeb<sup>7</sup> sent several years ago. Hill's questionnaire revealed 27 deaths from hemorrhage, while that of Loeb disclosed 62 deaths from this cause, 19 from general sepsis, 7 from meningitis and 21 from undetermined causes. At that time Loeb stressed that "Many of the cases reported carry with them important lessons of indication and contraindication, of inexperience, of danger of multiple operation and postoperative inattention and of unforeseen accident." Among his cases were death from hemorrhage due to myelogenous leukemia and hemophilia.

The greater variation in mortality figures would indicate the wide difference in the methods employed and the difference in organization and personnel which is involved. The figures quoted from three clinics:

|            |                                |        |
|------------|--------------------------------|--------|
| Jones..... | Manhattan Eye and Ear Hospital | 52,467 |
| Martin.... | Royal Infirmary, Edinburgh     | 14,690 |
| Myerson... | Kings County Hospital          | 10,305 |
|            |                                | 77,732 |

without a single death from hemorrhage, are significant. The only inference which one can draw is that the operations were performed by experts or supervised by such in a well regulated and well organized operating unit.

The organization of the ward or floor where the postoperative care is carried out is of equal importance to the organization of the operating room. Nurses assigned to tonsillectomy cases should have special training in this work. Nurses who are not so specially qualified may fail to appreciate

such symptoms of bleeding as constant swallowing, restlessness, increased pulse rate, and pallor. The surgeon should warn the nurse whose competency he may doubt, that she should not rely upon her own judgment, but should, rather, notify the house surgeon or special resident in case of doubt. Nurses in small private hospitals should be warned not to be reluctant to call the surgeon, regardless of the hour. The pulse rate should be counted every ten minutes during the first two hours after operation, and at least frequent intervals as the time passes. In cases of severe hemorrhage it is not fair to depend upon the interne to control the bleeding. Somebody well trained and experienced should respond.

A knowledge of the causes is important if we are to have less of this complication. At the top of the list I would place improperly and poorly executed operations under unfavorable conditions. It should be emphasized that the doctor's office is not considered the best place for the performance of the tonsil and adenoid operation. Nor is it the best place for the care of these patients. Tonsillectomy is not a minor operation. Most of the hazards which are involved in tonsillectomy and its after care are due to ignorance, indifference, inexperience or carelessness in some phase of the operation. It is therefore urged that the operation be done in a well organized hospital where careless and hurried work under unfavorable conditions is not only not permitted but practically impossible.

The causes of hemorrhage following the tonsil operation might be listed as primary, recurring and secondary. Primary hemorrhage is considered to be hemorrhage that is present at the time of operation and continues unchecked after the patient leaves the operating room. Recurring hemorrhage is that which has reappeared soon after operation. Secondary hemorrhage is that which occurs sometime after operation, usually after twenty-four hours have elapsed. Secondary hemorrhage has been known to occur as late as ten to fourteen days after operation.

#### CAUSES OF PRIMARY HEMORRHAGE

1. Failure to control bleeding at the time of operation;
  - a. Remnant of tonsil or adenoid tissue left behind,
2. The presence of acute or subacute inflammation at the time of operation;
3. Vitamin c deficiency;
4. Blood dyscrasias; as severe secondary anemia, pernicious anemia, leukemias, hemophilia, purpura, Hodgkin's disease;
5. Cardiac conditions, atherosclerosis, hypertension;
6. Anomalies of blood vessels;
7. Menstruation.

#### RECURRING HEMORRHAGE

Usually due to yelling, crying, struggling, straining or coughing shortly after operation, and is readily confused with primary hemorrhage.

*Secondary Hemorrhage.* 1. Stress or strain,

- a. Sexual excitation;
- b. Emotional strain;
- c. Undue physical exertion; forceful yawning has caused secondary hemorrhage by stretching the healing wound and tearing blood vessels.

A hurried and rough tonsillectomy results in undue injury to the tonsillar fossa, with a resultant increase in bleeding. It is important that the operation be done deliberately, gently and with the exercise of care. When so performed the amount of bleeding is greatly reduced.

Let us consider the various causes of hemorrhage following tonsillectomy which are not directly related to technique:

1. The presence of acute or subacute inflammation. The increased blood supply which is present because of active inflammation may be the cause of embarrassing bleeding.
2. Vitamin c deficiency. While visiting the Harper Hospital in Detroit last Summer I was impressed with the work which had been done on the relationship of Vitamin c deficiency to obscure or unexpected post-operative hemorrhage. It was pointed out

that individuals in all stations of life may be prone to hemorrhage following operation because they have avoided the ingestion of fresh fruits.

3. Blood dyscrasias. The influence of a pathological condition of the blood cells upon coagulation and bleeding is well known.

4. Cardiac, hypertensive and atherosclerotic conditions. The local tissues will show evidence of stasis or passive congestion in certain cardiac conditions. The hypertensive and atherosclerotic individuals bleed more than is usual, for obvious reasons.

5. Menstruation. We do not agree that there is any danger of increased bleeding in the menstrual state. We do feel, however, that the prospective patient will withstand her operation and period of convalescence better if the operation is performed at a time other than during the menstrual period.

6. Anomalies of blood vessels. The pharynx should be inspected for abnormal pulsations. If such exist and the position of the internal carotid artery cannot be ascertained, it might be advisable to cancel the operation.

7. Sexual excitation is a much more frequent cause of secondary hemorrhage than is generally known. A careful check of the causes of secondary hemorrhage in hospital and private practice revealed this to be the most frequent factor in this type of bleeding. Physicians should have no compunction about warning their patients concerning this cause of late bleeding following tonsillectomy.

8. Infection occurring in the tonsillar wound will cause softening of the occluding clot in a blood vessel and its extrusion. This causes the most troublesome type of tonsillar bleeding and may recur every few days.

The accompanying reproduction of drawings originally published by Fetterolf<sup>2</sup> illustrates the blood supply of the tonsil (Fig. 1). The lateral or attached surfaces presents a thin but firm fibrous capsule which is continuous with the pharyngeal aponeurosis and is in contact laterally with the superior constrictor muscle of the

pharynx. On the lateral surface of the superior constrictor muscle is the thin buccopharyngeal fascia. The ascending pharyngeal and ascending palatine arteries and the tonsillar branch of the external maxillary artery are in relation with the structures forming the tonsillar fossa from behind forward. The tonsillar branch of the dorsalis linguae artery approaches this region from below, while the descending palatine approaches it from above. The peritonsillar and pharyngeal venous plexuses are related to the anterior surface of the buccopharyngeal fascia and the superior constrictor muscle. If the operation is carried beyond the superior constrictor fibres, these blood vessels will be endangered. At times the superior constrictor is extremely thin and almost absent, so that the tonsillar capsule will be very close to the arteries and veins. Because of this the integrity of the superior constrictor muscle and the thin fascia beyond it must be maintained.

There are four principle arterial branches which supply the tonsil:

1. Anterior tonsillar artery—branch of the dorsalis linguae.
2. Superior tonsillar artery—branch of the descending palatine.
3. Posterior tonsillar artery—branch of the ascending pharyngeal.
4. Inferior tonsillar artery—branch of the dorsalis linguae.

According to Schaeffer<sup>15</sup> there is usually a distance of 2.5 to 3.5 cms. between the superior constrictor muscle and the internal and external carotid arteries. Occasionally however, the internal carotid artery may be very tortuous, creating abnormal pulsations in the pharyngeal walls. Although there are no branches coming from the cervical portion of the internal carotid artery, the ascending pharyngeal, occipital, and lingual branches may occasionally arise from it. So that a tortuous internal carotid artery might come very close to the capsule, or its ascending pharyngeal branch might be dangerously close. Schaeffer<sup>15</sup> reported 3 fatalities due to hemorrhage complicating tonsillectomy as a result of injury to tortuous and closely placed

internal carotid arteries. In these cases the usual distance between the tonsillar bed and the artery was no longer present.

of the pharynx. It is therefore of great value to have the pulse rate recorded as a routine every ten minutes during the first

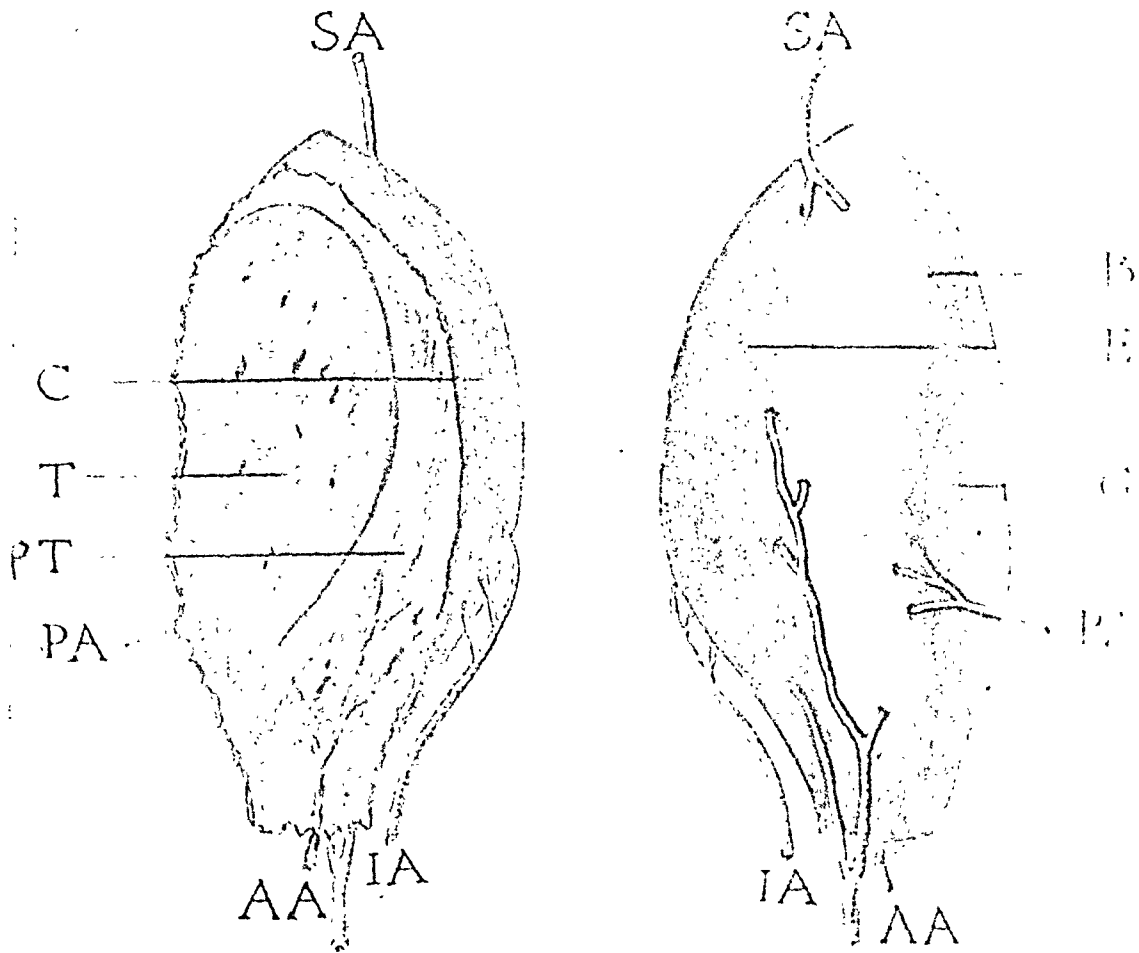


FIG. 1. Left tonsil with arterial supply, slightly enlarged (after Fetterolf). 1, mesial aspect; 2, posterolateral aspect. T, tonsil tissue; PT, plica triangularis; C, capsule; AA, anterior tonsillar artery; PA, posterior tonsillar artery; SA, superior tonsillar artery; IA, inferior tonsillar arteries; E, lateral surface; B, posterior surface; G, groove for palatopharyngeus.

#### SYMPTOMS

One would expect that bleeding from the tonsillar wound would be evidenced by the expectoration of fresh blood in all cases. Unfortunately this is not so, especially in those patients who have had a general anesthetic and are not yet fully awake. If such a patient is placed in the prone or semi-prone position immediately after operation and kept so until he is fully awake, blood will be detected coming from his mouth, if he is bleeding.

Constant swallowing is an important sign of bleeding and one should closely watch for it in the patient reacting from a general anesthetic. In addition, restlessness and an increased pulse rate indicate bleeding and should lead to an examination

two hours, and at less frequent intervals as the time passes. A gradually increasing pulse rate is indicative of loss of blood. Vomiting should be closely watched. This symptom is expected in most general anesthesia cases. If fresh blood appears in such vomitus, however, bleeding should be suspected. If the patient should vomit a second time it would indicate that he is very likely bleeding. A rapid pulse, pallor and restlessness are late and urgent symptoms. It is preferable not to wait for these to occur.

#### TREATMENT

Of first consideration should be the prevention of hemorrhage. Let us consider each cause from this standpoint.



1. Failure to control bleeding at the time of operation. The operator should be certain that remnants of tonsil or adenoid tissue are not left behind.

2. The presence of acute or subacute inflammation at the time of operation. The recognition of such a local condition and the postponement of the operation present no problems.

3. Vitamin c deficiency. All patients should be given extra fruit juices for two or three days prior to the time of operation.

4. Blood dyscrasias. Careful history taking and physical examination will eliminate this cause of trouble.

5. Cardiac, hypertensive and atherosclerotic conditions. When operation must be done, careful supervision by an internist is essential. He should advise the surgeon when it would be best to operate.

6. Menstruation. We do not feel that there is any basis for the claim that the coagulability of the blood is unfavorably influenced during the menstrual period. However, we prefer to perform the operation at other times, when the individual is in better physical condition.

7. Anomalies of blood vessels. Pulsations indicative of such abnormality are usually present in the pharynx. One should be prepared for carotid ligation in the presence of anomalies. Fortunately, these conditions are extremely rare.

Recurring hemorrhage, which is usually due to yelling, crying, struggling, straining, or coughing shortly after operation, can best be avoided by the use of appropriate sedatives when the patient is returned to bed. For this purpose codeine or codeine and aspirin suppositories are of great value.

Secondary hemorrhages other than those due to infection of the wound can be avoided by carefully instructing the patient against emotional and physical types of stress and strain. The frequent role of sexual excitation as a cause of secondary hemorrhage is stressed. Infection of the wound and loosening of the clot in the occluded blood vessel can best be avoided by strict adherence to asepsis during operation.

Hemorrhage occasionally occurs at the site of removal of the adenoid tissue. Our view is similar to that of Jones, who contends that the curette causes more bleeding than the LaForce or blade type of adenotome. It is well to inspect the nasopharynx by elevating the soft palate with a suitable instrument before using any instrument in this region. At times inspection will disclose that no adenoid tissue exists. In such a case the blind, routine use of a curette or adenotome will result in unnecessary injury to the tissues.

Bleeding from the adenoid region is best controlled by pressure with a firmly fitting sponge. If this does not suffice to stop the bleeding, the soft palate should be elevated and a hemostat used upon the bleeding point. Pressure usually suffices to stop bleeding in this region; it is rarely necessary to tie a bleeding vessel.

Primary hemorrhage should be dealt with at the operating table. If for any reason a patient has been sent to his bed and is still bleeding, it is preferable to take him back to the operating room. A patient who has previously had a general anesthetic should be reanesthetized unless the bleeding can be readily controlled. An adult who has had local infiltration anesthesia should have the benefit of some additional anesthetic before instrumentation of any extent is carried out. The reanesthetization enables the surgeon to work more smoothly.

How should bleeding at the time of operation be handled? We must presuppose that every precaution has been taken and that the operator has performed a gentle, clean, deliberate, careful and complete operation. It should be remembered that each blood vessel has its retraction time and that it takes a few minutes before the process of coagulation is completed. The gentle placement of a gauze sponge in the tonsillar fossa for a few minutes will prevent unnecessary loss of blood during this process. Bleeding may come from anywhere in the fossa. Three points which are especially difficult to reach are high up in the fossa; low down in the fossa; and behind the anterior pillar. Isolate and tie off the

bleeding point. If this is not possible, pack a piece of gauze into the fossa and leave it there for six to eighteen hours. It might be necessary to suture through the tonsillar pillars in order to hold the gauze in place. In fact, it is the safer thing to do. When bleeding is from the posterior aspect of the anterior pillar it is often necessary to evert the pillar to bring the bleeding point into view.

A suction apparatus and a proper suction tip is indispensable in this operation. The suction, however, should be used gently and for brief periods of time. It must be remembered that unnecessary and rough use of the suction tip will cause bleeding.

If there is still active bleeding after the removal of the gauze sponge, suitable hemostats of the Carmolt or Kelly type should be used to clamp the vessel. If the vessel is very small the mere crushing with the hemostat will suffice. If bleeding still continues a ligature should be tied around the bleeding point. This is done in the same manner as the surgeon ties a ligature when performing intra-abdominal or pelvic surgery. Special ligature carrying and tying instruments are available for those who do not wish to use the usual hemostats.

If the bleeding is general and comes from several different places, so that it cannot be localized, the quickest and easiest method of handling it is to sew a sponge into the tonsillar fossa. The suture should always pass through the posterior pillar first because the extreme thinness of the anterior pillar permits the needle to tear the tissues if the suture passes through that structure first. A single suture through the pillars will usually suffice to hold the sponge in place. On rare occasions a second suture may be required. It is best first to place the suture before introducing the gauze sponge. This is held directly beneath the loop of the suture with a hemostat. A non-slip knot should be used in tying. The gauze and suture may be removed in twelve to twenty-four hours.

At times it becomes necessary to use a suture ligature instead of a simple ligature in the tonsillar fossa. In many instances

this is very difficult. Therefore the placement of a gauze sponge in the fossa makes a good substitute. An objection which seems to have some basis is that the needle which carries a suture ligature may infect the deep tissues of the neck.

Many laryngologists use caustics, styptics, and astringents for bleeding from the tonsillar fossa. These are not only unnecessary but, in many instances, are harmful. Such medicaments as silver nitrate, tincture ferrichloride, Monsell's solution, peroxide of hydrogen, are of no value when a blood vessel has been cut. Even when there is fine capillary oozing, these agents tend to devitalize the tissues and favor secondary hemorrhage. Peroxide of hydrogen is a dangerous agent to use for this purpose. It is used extensively, yet it is a well known fact that peroxide dissolves fibrin and disturbs the process of clotting. It causes a foam which can so obstruct the larynx as to shut off the air and endanger the life of the patient. This is especially true where the bleeding is active. The writer knows of a case where tracheotomy became necessary because peroxide was used.

The use of clamps of the Mikulicz type is popular in some quarters. These instruments act as a vise between the jaws of which are placed the tonsillar fossa and all the structures to and including the skin. This is a painful and uncomfortable procedure which should rarely be necessary.

Medications which have a physiological basis, such as thromboplastin, hemostatic serum, kephalin, coagulose, coagulen and similar products are of value in general oozing. Greene<sup>3</sup> advocates the use of the hemostatic properties of the patient's own tissues. He employs the placement of the detached tonsil in the fossa for control of hemorrhage during and after the operation.

A clot in the tonsillar fossa indicates a bleeding point underneath. The clot should be gently removed and the hemorrhage treated as mentioned. When controlling hemorrhage in the ward or in the patient's room good light and a suction apparatus are essential. Therefore the laryngologist who treats a case of posttonsillectomy

hemorrhage should take his suction apparatus with him.

Secondary bleeding may be more difficult to control. This is especially true in the cases due to infection. In such a case bleeding occurred every two or three days for twenty-one days after operation.

A rare but serious type of complication is that of hemorrhage into the soft tissues about the tonsillar fossa. Schall<sup>16</sup> had a patient who, after a tonsillectomy under general anesthesia, developed a hemotoma of the soft parts, which threatened to asphyxiate him. A tracheotomy was necessary.

Transfusion is universally used for replacing lost blood and, therefore, need hardly be mentioned.

As a final word, let us emphasize that tonsillectomy is a major operation and that the same attitude should obtain in this procedure as toward all other major surgery.

#### SUMMARY

The paper contains a short, historical note on the subject of hemorrhage following tonsillectomy. The causes of hemorrhage which are listed, are divided into primary, recurring, and secondary. Consideration is given to avoidance of hemorrhage by attention to these causes. Two causes of hemorrhage complicating tonsillectomy which are not generally known, are stressed. As a cause of primary hemorrhage vitamin c deficiency plays an important role in many cases. Because of this the author gives his patients fruit juices for two or three days prior to the time of operation. Sexual excitation is the most frequent cause of secondary hemorrhage in the writer's experience.

Death from hemorrhage should not occur in the light of our present knowledge; 77,732 tonsillectomies are listed from three different clinics without a death from hemorrhage.

Tonsillectomy is not a minor operation. Improperly and poorly executed operations under unfavorable conditions are frequent factors in severe hemorrhage. Most of the

hazards in tonsillectomy and its after care are due to ignorance, indifference, inexperience or carelessness. For this reason such operations should be done in well organized hospitals. A deliberate, well planned and careful operation will insure a minimum of complications. The treatment of hemorrhage is outlined and various methods evaluated.

#### REFERENCES

1. CELSUS. Quoted by Packard, Francis R., ref. 11.
2. FETTEROLF, GEORGE. The safeguarding of the tonsil and adenoid operation. *Am. Jour. Med. Sc.*, 164: 884. (Dec.) 1922; *Anatomy of the tonsil. Am. Jour. Med. Sc.*, 144: 37 (July) 1912.
3. GREENE, JOSEPH B. Further experiences in the use of tissue juices. *Boston Med. and Surg. Jour.*, 189: 200 (Aug. 9) 1923.
4. HILL, L. G. Hemorrhage following tonsillectomies. *Journal-Lancet*, 39: 170 (April) 1919.
5. HUNT, W. M. Coagulation time prior to tonsillectomy. *Ann. Otol. Rhinol. and Laryngol.*, 36: 187 (March) 1927.
6. JONES, DAVID H. Preparation and management of patients prior to and during the tonsil operation. *Tr. Am. Acad. Oph. and Oto-Laryngol.*, 39: 327, 1934.
7. LOEB, HANAU. Further studies of fatalities following operations on the nose and throat. *Ann. Otol. Rhinol. and Laryngol.*, 32: 1103 (Dec.) 1923.
8. MACKENZIE, MORRELL. Diseases of the Pharynx, Larynx and Trachea. New York, William Wood & Co., 1880.
9. MARTIN, G. E. Complications following removal of tonsils. *Jour. Laryngol. and Otol.*, 37: 80 (Feb.) 1922.
10. MCKINNEY, RICHMOND. Coagulation test. *Arch. Otolaryngol.*, 6: 158 (Aug.) 1927.
11. PACKARD, FRANCIS R. Some historical considerations on the removal of tonsils. *The Practitioner*, 124: 59 (Jan.) 1930.
12. Paul of Aegina. Quoted by Packard, ref. 11.
13. PHYSICK, PHILIP S. Case of obstructive cough, etc., with instrument—also for excision of scirrhus tonsils. *Am. Jour. Med. Sc.*, 1: 262 (Feb.) 1827.
14. RICHARDS, GEORGE L. Report of five hundred cases of consecutive tonsillectomies, etc. *Boston Med. and Surg. Jour.*, 192: 304 (Feb.) 1925.
15. SCHAEFFER, J. PARSONS. Aberrant vessels in surgery of the palatine and pharyngeal tonsils. *J. A. M. A.*, 77: 14 (July) 1921.
16. SCHALL, LEROY A. Hematoma of the soft tissues necessitating tracheotomy. *Laryngoscope*, 36: 666 (Sept.) 1926.
17. SLUDER, GREENFIELD. Technique of tonsillectomy. *Proc. A. M. A., Sect. L. R. and O.* (June 9) 1910.
18. TILLEY, HERBERT. Discussion on problems presented by hemorrhage in tonsil operations, etc. *British Med. Jour.*, 2: 431 (Sept. 17) 1921.
19. WHILLIS, S. S. and PYBUS, F. C. The enucleation of the tonsil with the guillotine. *Lancet* 2: 875, 1910; *Brit. Med. Jour.*, 2: 1402, 1911.

# PERITONSILLAR ABSCESS

CHARLES REED WEETH, M.D., F.A.C.S.

Assistant Professor in Otolaryngology, Long Island College of Medicine; Attending Long Island College and Cumberland Hospitals; Associate Attending, Brooklyn Eye and Ear Hospital

BROOKLYN, NEW YORK

**P**ERITONSILLAR abscess, or quinsy, is defined by its name. It is an abscess outside of or beyond a tonsil and hence lies between a tonsil and its muscle bed, usually involving the faucial or palatal tonsil but it may also be the lingual tonsil. The latter type of peritonsillar abscess is rare but when it does occur the tongue as well as the adjacent neck may become seriously involved. In quinsy the patient is greatly distressed but is usually not septic nor too ill to cooperate. Thus treatment of this condition may be accomplished at home and sometimes in the office.

Peritonsillar abscess develops as a complication to tonsillo-pharyngitis. The virulence of the invading organism, the obstruction to drainage of tonsillar crypts due to exudate and debris in the lacunae, and the amount of edema all contribute toward a peritonsillitis and pharyngeal myositis, the latter causing the pain on swallowing. Sometimes a supratonsillar crypt well covered over by the supratonsillar mucosal fold or plica, runs deeply through the tonsil almost to the tonsil capsule and must contribute greatly to the incidence of peritonsillitis. It is because of this sinus supratonsillaris that the most frequent development of abscess occurs about the upper tonsillar pole.

When peritonsillitis is developing and abscess formation is likely, great caution must be exercised and any incision avoided, either into the tonsil or the palate. Incision into a tonsil at this time has apparently been the cause on a number of occasions of tonsillar abscess, a condition likely to produce sepsis and death. As the peritonsillitis develops in the loose tissues about the tonsil, abscess formation occurs, usually superior and external to the tonsil

and causing protrusion of the palate forward and dislocation of the tonsil medially and somewhat downward. Any extension downward behind the tonsil or abscess formation independently near the tonsil base causes great edema because of venous obstruction. As the quinsy develops dysphagia is great and stout fixation of the jaws is characteristic because any motion here increases the great pain and distress.

Because of the edema and the fixation of the jaws the tonsil itself is difficult to see. But the supratonsillar fold or plica can usually be observed and so can the red and swollen palate which is projected forward. Thus the two surgical approaches are at hand despite the inability of the patient to open the mouth more than very little. It must be remembered that the tonsil always occupies a fossa the upper part of which is always domed into the palate above the base or the root of the uvula. The tonsillar vessels enter the fossa through the top of this vault and also near the tongue base. If the base of the uvula is used as a guide one may be certain that the blood vessels enter the fossa at a higher level than this. Also they quite invariably lie in or on the posterior and external muscle walls. Thus incision of the usual supratonsillar abscess may be accomplished with very reasonable safety if these points are kept in mind.

Operation is best accomplished without anesthesia. Local anesthesia is of little value. Swabbing causes pain. Tension, as well as spread of the infection is likely if infiltration is attempted. Spray anesthesia renders so much of the pharynx unmanageable that mucus and evacuated pus might be aspirated into the trachea with self evident dangers. General anesthesia is not favorable unless one is positive that no

cooperation can be enlisted and that the abscess is such that it will not rupture during stress incident to the taking of anesthesia. Suction apparatus would of course be necessary.

When one is certain that an abscess has formed it is not necessary to permit hours or days of pain and distress to continue before operation merely to permit greater localization or larger abscess formation as a convenience to evacuation of the pus. The abscess may be incised through the palate at the site of greatest redness and fluctuation, at or just above the level of the base of the uvula. A very thin sharp blade is best. Once it has been introduced, cutting edge down, it causes no more pressure hence no increase of pain, and if some pus escapes pain is reduced. Thus, haste or quick slashing incision is unnecessary and unwarranted. If the blade is now carefully and deliberately advanced, while a slight rotary oscillation of its handle is made, vessels will not be cut, and likewise the tonsil capsule will not be entered, and the abscess depth will usually be found quite easily. If the handle is now elevated and inclined outward so the point of the knife is lowered somewhat medially, the blade can be quickly and deliberately withdrawn, thus making a real incision  $\frac{1}{2}$  to  $\frac{3}{4}$  inch long with very little pain and definitely away from all large vessels.

A tongue depressor firmly but gently placed on the tongue up to the tumefaction, aids in the operation and protects the mouth as the withdrawn blade is brought out upon it. This procedure is the least painful, and very little if any spreading of forceps in the abscess cavity is necessary. The opening of an abscess here or elsewhere by the sudden forceful introduction of any kind of forceps, although perhaps considered safer, really need not be and certainly seems brutal.

The other surgical approach is through the supratonsillar fold. The superior border of the anterior pillar is followed to where it merges into the palate. This is usually

readily seen and the supratonsillar fold can be made out quite as easily. By a small incision of this usually loose fold, followed by probes or seekers of increasing size, into the supratonsillar space as described by Dobbs,<sup>1</sup> or using the special threaded instrument designed by Pelz,<sup>2</sup> excellent evacuation of the abscess can quite invariably be obtained through this route.

Having evacuated any superior abscess, the posterior aspect of the tonsil should be visualized, and a counter or dependent incision made if an inferior abscess exists, either as a separate entity or as a sort of sinking abscess from the one above it. This is not usually necessary, and edema here should be carefully considered and not misinterpreted as an abscess. Should a clot or exudate obstruct the palatal incision, and permit reaccumulation of pus, such obstruction can be easily picked out with forceps with very little discomfort. Further incision, or spreading, unless done very gently is almost never necessary. However, it will be found that a  $\frac{3}{4}$  inch incision is about half as big, as soon as the abscess is evacuated.

Hot irrigations and hot drinks, if they can be taken, benefit greatly both while localization is going on, and after drainage of the abscess. Early x-ray therapy may abort a peritonsillitis, and if not, hastens formation of an abscess which seems less great than was expected, and usually less tense and painful. Tonsillectomy, in the presence of quinsy abscess has been recommended and successfully done by Baum<sup>3</sup> and others, but is not generally an accepted procedure.

Danger points to be remembered are the vessels entering the upper part of the tonsillar fossa; the carotid artery, which is sometimes seen to pulsate the lateral wall of the fossa after removal of a tonsil; incision too far laterally, and in a lateral rather than somewhat medial direction, which

<sup>1</sup> DOBBS, O. R. *Laryngoscope*, 40: 186, 1930.

<sup>2</sup> PELZ, M. D. *Laryngoscope*, 40: 190, 1930.

<sup>3</sup> BAUM, H. L. *Annals Otology Rhinology and Laryngology*, 35: 429, 1926.

procedure might injure the carotid or introduce infection into the neck, and not accomplish the drainage of the abscess. As mentioned before it is best not to incise into the tonsil or through its capsule. Delay in relieving the abscess might permit spontaneous pharyngeal rupture with tracheal aspiration of pus; extension into the pterygo-maxillary area with more serious abscess formation; or gravitation abscess down the neck into the mediastinum. Involvement of the glottis by edema is rare, but does happen.

Peritonsillar abscess always shows the usual signs of an abscess and definite tension of the palatal structures, and this differentiates it from tonsillar abscess, retropharyngeal adenitis or abscess, and tonsillar-palatal displacement due to new growth or cervical adenitis. Peritonsillitis occurs more commonly in adults with a large proportion forming abscess. In children it most frequently subsides. Likewise children form suppurative adenitis far more frequently. Hansel<sup>4</sup> reports that Guiffrida concluded from 121 of his own cases in two years that the bacteria causing abscess were pneumococci 25 per cent; streptococci 23 per cent; staphylococci 1 per cent; mixed diplococci and bacilli, chiefly colon bacillus, 33 per cent; fusospirilla of Vincent 2.5 per cent; diplococci and streptococci 11 per cent; diplococci and staphylococci 4 per cent.

Peritonsillar abscess may recur numerous times about one or both tonsils, but rarely in both in the same attack. It may be a locally distressing but otherwise uneventful disease; or it may produce the gravest sepsis with numerous metastatic complications, hemorrhage by blood vessel

erosion, locally or in metastatic sites, and death. Thus, the clinical state of the patient, and the course of the disease, should determine whether or not the condition is one which can be managed as a case in minor surgery, or one calling for the most elaborate regime and support.

#### CONCLUSIONS

Peritonsillar abscess occurs in the anatomic space between a tonsil and the pharyngeal muscles forming its fossa.

It usually occurs in the palatal portion of the fossa bulging the palate forward and dislocating the tonsil medially and downward delineating the supratonsillar fold. In the surgical attack the palatal bulge and the supratonsillar fold are the two approaches and both are accessible despite trismus. The base of the uvula is a surgical guide in avoiding the superior or chief tonsillar blood vessels.

Careful adequate incision is much preferred to any rupturing or blunt forceful evacuating of a peritonsillar abscess.

Local anesthesia is of little or no value and inhalation anesthesia has the danger of aspiration of discharges ever present.

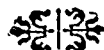
X-ray therapy early is abortive or hastens localization.

Occurrence is chiefly in adults and rarely is bilateral in one attack. Recurrence is common.

Pneumococci, streptococci, and diplococci with Bacilli coli seem to account for about 80 per cent of these abscesses.

Peritonsillar abscess, a very distressing experience, may usually be managed at home and evacuated there or in the office. It may also be a most serious complicating disease requiring all the elaborate supportive measures only to be had in the hospital.

<sup>4</sup> HANSEL, F. K. *Archives of Otolaryngology*, 24: 629, 1936.



# ACUTE RETENTION OF URINE

CLARENCE G. BANDLER, M.D., F.A.C.S. AND ARTHUR H. MILBERT, M.D.

Professor of Clinical Urology

Instructor in Urology

New York Post-Graduate Medical School and Hospital, Columbia University

NEW YORK

ACUTE retention of urine represents a highly significant clinical syndrome as encountered either by the internist, surgeon or urologist. Inability to pass any urine per urethram after repeated attempts at voluntary micturition may sound a danger signal warranting not merely relief of immediate symptoms but careful investigation for underlying pathology. Too often the effect is treated with utter disregard of the cause. Morbidity and mortality would be markedly diminished if cause and effect were revealed and suitable therapy instituted.

Any obstructive lesion of the lower urinary tract, from internal sphincter to external urethral meatus, may account for complete interruption of the urinary stream. Apart from the dynamic mechanical types, one may encounter adynamic neurogenic lesions. It would be more accurate in defining acute retention of urine to include the upper urinary tract. This broader interpretation is expressed as the inability of the renal pelvis, ureter or bladder to discharge any of its urinary contents.

One should be mindful of the fact that acute inflammation with its attendant edema, either independent of, or superimposed upon anomaly, neoplasm or calculus of the kidney, renal pelvis, ureter or bladder, is capable of producing acute localized urinary obstruction. Associated with such unilateral pathology is the ever-present danger of reflex inhibition of urine on the opposite side, or even absence of the kidney, a finding noted in 0.04 to 0.1 per cent of all individuals. For purposes of simplicity, however, we shall confine our presentation to the lower urinary tract.

It is also beyond the scope of this paper to discuss chronic retention of urine. In

such instances, micturition is possible though curtailed in varying degrees. The underlying pathology in both chronic and acute urinary retention may be the same. Sudden shock, overindulgence in alcohol or coitus, exposure to cold, or acute infection may convert a chronic case into an acute one.

The usual clinical picture of acute urinary retention is that of a thoroughly uncomfortable patient, with anxious facies and unable to stand still or lie quietly in bed. While pain is predominant in the majority of cases, its absence in no way alters the acuteness of the condition. An individual whose bladder sensibility is impaired or absent due to peripheral or central nervous system infection or injury demands just as much attention as the more animated type.

To complete and to clarify our conception of acute retention, one must exclude anuria, or acute suppression of urine. In both instances there occurs an inability to pass urine. The former is predicated on the presence of an excessive volume of urine in the bladder, the latter, on renal secretory inhibition. The distended viscus may be visible, dull to percussion and palpable. In anuria the bladder cannot be outlined by percussion or palpation and contains little, if any, urine, as confirmed by catheterization.

## INCIDENCE

Inability to void is usually associated with urethral stricture in the youth and prostatism in the aged. Undoubtedly these two groups account for many cases of acute retention. However, no age is exempt from the incidence of underlying lesions and the precipitation of the clinical

emergency. Newborn, youth, middle-aged and aged are, as we shall show, victims of the condition.

Sex predilection is of no real significance. Acute retention occurs in the female as well as in the male. True, diseases of the prostate gland and the greater susceptibility of his urethra to gonorrheal stricture formation undoubtedly produces an incidence elevation in the male. Furthermore, the vigorous activity of boys at play and the greater number of men at work, make the male more susceptible to such injuries which may directly, or indirectly, produce acute retention. Gynecological disorders, in turn, cause numerous instances of acute obstruction to the outflow of urine in women.

#### ETIOLOGY

With the exception of isolated cases of hysterical or reflex (postoperative) retention of urine, careful urologic investigation will reveal a basic cause for the obstruction. Such causes may be classified as anomalies, infections, new growths, trauma, neurogenic lesions, urolithiasis, foreign bodies, psychic or reflex phenomena, and a miscellaneous group comprising rarer occurrences.

Pathological entities will be found to fall into certain age groups. Thus, anomalies frequently manifest themselves in childhood, although occasionally the condition passes unnoticed until superimposed infection precipitates acute obstruction in the adult. The twenty to forty year age group is characterized chiefly by gonorrheal strictures in the male and pelvic disorders in the female. In the group over fifty years of age, vesical neck obstruction due to prostatic disease and gynecological maladies predominate.

#### DIAGNOSIS

The diagnosis of acute retention of urine is usually self-evident. In most instances pain is an outstanding symptom, and its relief represents the chief immediate concern of both patient and doctor. History

of antecedent urinary difficulties, injury, operation, or disease (gonorrhea, syphilis, urolithiasis etc.) may be obtained. Such conditions will be presented in greater detail as disease entities are considered.

Dribbling of urine should make one suspect a condition of "paradoxical" incontinence due to urinary overflow from an overdistended bladder. Such instances are usually associated with neurogenic diseases. An ataxic gait, sensory changes and other neurological findings readily identify the tabetic. In true urinary incontinence there is little or no urinary retention.

On physical examination, the patient may be extremely agitated, perspiring freely and tossing about. Inspection of the hypogastric region may reveal a visible midline swelling; the mass is tense and tender to touch, movable from side to side (within pain limits), with rounded upper contour and merging with the symphysis below. Percussion yields flatness over the tumor, in contrast to a tympanitic note elicited laterally and superiorly. Rectally, a cystic tumefaction may be palpated. During the course of this procedure one may disclose the cause of the condition with the finding of an enlarged or stony hard nodular prostate gland. Urethral catheterization, of course, definitely establishes the diagnosis of retention of urine.

#### ANOMALIES

Malformations of the urinary tract account for most obstructive uropathies in infancy. The sequel of obstruction, stasis and infection is allied with a state of chronic or acute retention of urine. Complete or partial phimosis, paraphimosis, atresia or constriction of the external meatus, strictures or atresia of the urethra, posterior urethral valves, hypertrophy of the verumontanum, and contracture of the vesical neck represent such etiological factors. In the case of complete atresia, an acute emergency exists and life-saving measures must be instituted. In other conditions, premonitory signs and symptoms usually manifest themselves but



infection often transforms a chronic obstruction into an acute one.  
Complete atresia of the urethra is,

probe or by spreading the blades of a mosquito clamp inserted through the tiny aperture. If necessary, a dorsal slit of the



FIG. 1. Urogram demonstrating extent of obstructive uropathy caused by posterior urethral valves. (Courtesy Dr. S. R. Woodruff.)

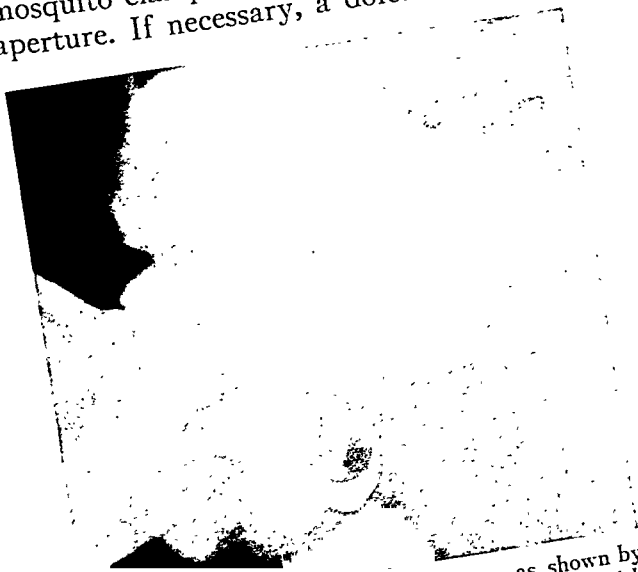


FIG. 2. Hypertrophy of verumontanum as shown by urethrocytography in a four year old boy with partial urinary obstruction.

fortunately, a rare occurrence. Many such cases pass unnoticed in the absence of post-mortem examinations of stillbirths or those dying shortly after birth. Woodruff and Milbert<sup>1</sup> report a case of complete atresia of the urethra in a child who died one hour after birth. Autopsy revealed far advanced obstructive uropathy involving the posterior urethra, bladder, ureters and kidneys. Even timely intervention in such a case would have been unavailing, but Birdsall<sup>2</sup> performed external urethrotomy on a child similarly affected six hours after birth which proved to be a life-saving measure.

Congenital anomalies of the prepuce are readily amenable to treatment. A pinpoint orifice may be bluntly stretched with a

prepuce or a circumcision can be done. Several cases of obstructive uremia have been reported due to prolonged chronic back pressure produced by extreme phimosis.

Strictures of the external meatus represent the most common form of urethral narrowing and are especially prone to complete obstruction when infection with acute inflammation and edema of the glans supervenes. In the newborn, a veil may completely occlude the meatus and simply nicking the almost translucent membrane will result in spontaneous urination and disappearance of a palpable hypogastric mass. Meatal strictures of varying calibre may be progressively dilated with filiforms and bougies or subjected to meatotomy, using a No. 11 blade or bistoury.

The attending obstetrician should assume the responsibility of noting any evident pathology of the external genitalia, the correction of which may be of immediate or remote importance. Failure of the child to void within the first eighteen hours warrants determination of the patency of the urethra. This may be done with a small bougie or catheter. Occasionally such a

procedure will separate or perforate membranous adhesions of the urethral mucosa. In extreme cases more radical surgery is indicated on the urethra or bladder. Posterior urethral valves (Fig. 1), hypertrophy of the verumontanum (Fig. 2) and contracture of the vesical neck may be remedied by using the transurethral cutting or fulgurating electrotome.

### INFECTIONS

Non-specific infections are of little significance unless they give rise to an inflammatory process engrafted upon an existing point of constriction. Previously mentioned urethral anomalies, phimosis and paraphimosis are prone to produce acute obstruction when complicated by infection. Treatment is usually expectant and external lesions respond to wet dressings of boric acid, potassium permanganate or subacetate of aluminum. Gonorrhea represents a particular menace to normal urinary function. Carelessness of the patient or faulty and indiscreet manipulation by the physician may result in such periurethral edema as to obstruct the urethral channel. Periurethral abscess or phlegmon, acute prostatitis, or prostatic abscess may similarly arise and cause acute retention of urine.

Treatment of such acute inflammatory obstructions should always be conservative. Rest in bed, hot sitz baths, hot rectal irrigations, sedatives and rectal suppositories of opium and belladonna are prescribed. Usually this regime results in regression of the acute symptoms. The patient may be advised to attempt micturition while immersed in a warm bath which has a soothing and relaxing effect upon sphincter spasm and urethral congestion.

Occasionally radical steps are necessary to relieve the more acute and extensive processes. Suprapubic cystotomy, external urethrotomy or incision and drainage of an abscess may be indicated. In the case of prostatic abscess, intra-urethral rupture of the suppurative focus has been effected by blind manipulation with a sound. We prefer either the transurethral approach under

vision, using the McCarthy resectoscope with cutting or fulgurating electrotomes, or perineal incision and drainage.

Suprapubic cystotomy, while outwardly a radical step, may be a most conservative and economic measure. By side-tracking the urinary flow temporarily, the affected area is put at rest with rapid involution of the inflammatory process. Urethral instrumentation can then be carried out at a later date. To attempt such instrumentation in the acute phase one faces the danger of producing a blood stream infection, urethral injury and urinary extravasation, if it is not already present.

### URETHRAL STRICTURE

Because gonorrheal stricture of the urethra accounts for many cases of acute retention we have chosen to deal with it separately. Neglect, inadequacy of treatment, willful or accidental use of strong anti-gonorrheal urethral medication may result in partial or complete constriction of the urethra. Progressive diminution in the urinary stream may be noted with sudden cessation occurring after exposure to cold, overindulgence in alcohol or coitus, or too vigorous instrumentation.

Gentleness is essential in attempting to relieve such urethral obstructions. Placing the patient in a hot tub bath may result in partial relief of the acute retention. Passage of a small sized sound or bougie will indicate the approximate location and degree of the obstruction. Sterile albolene or olive oil may be instilled into the urethra as a lubricant prior to any instrumentation, or instead, a surface anesthetic of one of the various novocaine derivatives or 1 per cent diothane solution may be used and retained in the urethra with a penis clamp for ten minutes before instrumentation is attempted. A water-soluble lubricant can then be used. Any form of anesthesia will cause the operator to take greater liberties in instrumentation than necessary, with the ever present danger of further urethral damage. If deliberation and gentility are observed in the passage of filiforms, bougies

and other instruments, no anesthesia may be necessary.

Passage of a filiform bougie can be a



FIG. 3. Cystogram showing marked intravesical prostatic hypertrophy which caused acute retention. Suprapubic cystostomy (tube in place) was performed.

simple or very tedious performance. Patience is a prerequisite to success, for it may take half an hour and repeated attempts with one or more filiforms before the point of obstruction is passed. The use of multiple filiforms passed parallel to one another helps to localize an eccentrically placed passage through the strictured area. The Philips whip filiform and follower or the LeFort type are especially desirable. A small-calibered ureteral catheter may serve the twofold purpose of passing a point of constriction as well as effecting slow drainage.

Following successful passage of a filiform, it may be left indwelling in the urethra and fastened with thread or adhesive to prevent its dislodgement. The instrument acts as a splint for the passage of urine along side of it through the edematous canal. After twelve to twenty-four hours the inflammatory process will have so subsided as to permit the passage of graduated followers of the Philips type or of ordinary bougies.

In cases where the patient is seen after repeated unsuccessful attempts have been made by others, a period of rest and sedation should be given before resuming further instrumentation. Rarely is it necessary to perform suprapubic cystostomy or external urethrotomy for the relief of acute retention. Such procedures, together with

internal urethrotomy or dilatation, may be applicable in the subacute or chronic stages.

#### NEW GROWTHS

Prostatic obstruction due to benign hypertrophy or malignancy is the most common source of acute retention in elderly males (Fig. 3). A history of frequency, nocturia, dysuria, urgency and diminution of stream often is climaxed by acute retention. The immediate precipitating factor may be an upper respiratory infection, automobile ride, exposure to cold, alcohol or sexual excitement. It may also follow diagnostic or therapeutic measures such as cystoscopy, passage of a sound or prostatic massage.

Success in catheterizing such individuals depends upon possession of a suitable supply of catheters. An ordinary Nélaton soft rubber catheter may be sufficient. Depending upon the degree of edema, the tortuosity or distortion of the posterior urethra and the degree of elevation of the sphincter floor, one may try, in turn, a soft rubber coudé, natural curve, coudé or bi-coudé woven silk, or a soft rubber catheter threaded on a curved wire stylet to obviate "buckling" of the flexible tube. Steel catheters should be used only in extreme cases and then with caution. The smallest sized catheters should be used wherever possible to minimize trauma.

As emphasized in the treatment of urethral stricture, gentleness is paramount. Repeated unsuccessful attempts should be punctuated by a rest period both for patient and doctor. Sedation and local anesthesia can be given the patient in the meantime. A 1 per cent solution of diothane instilled into the urethral canal and retained by a penis clip will often bring gratifying results.

Having catheterized the elderly prostatic patient, gradual decompression of the chronically distended bladder should be effected. This may be carried out by drawing off four ounces of urine at one to two hour intervals or by attaching a Murphy drip tube to the catheter and regulating

the flow by a screw clamp to sixty drops a minute.

Creevy,<sup>3</sup> in analyzing 69 deaths following catheter treatment of retention, could find no proof that sudden decompression was the cause. However, shock, collapse, renal or vesical hemorrhage and anuria have been reported by others as direct results of sudden total evacuation of acutely distended bladders. Nothing is lost and much gained by observing precautionary measures. If too much urine has been withdrawn inadvertently, a safe procedure is to replace the fluid volume in part by sterile saline, boric acid or other antiseptic solution.

In addition to prostatism, vesical neck obstruction may be produced by benign or malignant bladder tumors at or about the internal sphincter. Just as a middle lobe may produce a ball-valve obstruction so can a pedunculated bladder tumor engage itself in the internal sphincter and lead to acute retention of urine. Inflammatory edema in prostatic or vesical malignancies can completely occlude the sphincteric lumen. Recently we encountered a case of acute retention of urine in a patient undergoing deep x-ray therapy for prostatic carcinoma. He had voided freely prior to the exposure to roentgen rays. Catheter drainage affords immediate relief in the mentioned conditions. Their subsequent treatment, other than immediate symptomatic relief, is not germane to our subject.

#### TRAUMA

Direct injury to the urethra or pelvis may cause a protective reflex retention of urine. Rupture of the urethra is best treated by suprapubic diversion of the urinary stream to offset any extensive extravasation at the site of injury. In selective cases and in expert hands, passage of a catheter along the roof of the urethra may be attempted.

Injuries to the spinal cord with resultant compression fractures, transverse myelitis or localized nerve tissue injury result in disturbed function of the sacral and sympathetic innervation to the bladder.

Diminished or absent sensibility of the bladder to urinary distention results in acute, painless retention of urine. Dribbling occurs as an overflow phenomenon and is referred to as "paradoxical" incontinence.

Catheterization of patients suffering from spinal cord injuries should not be done without specific indication. The patient may go days or weeks without voluntary micturition but a state of automatic bladder contraction will develop sooner or later. Massage, stroking the thighs or application of the Credé maneuver to the distended bladder will facilitate its emptying. Infection subsequent to catheterization in such cases is especially common and for this reason it should be avoided entirely or when done, strictest asepsis observed.

Either as a result of external trauma or urethral or vesical instrumentation, hemorrhage from the bladder wall or prostate may occur. Formation of large clots in the bladder may produce complete obstruction to the outflow of urine until they are evacuated. This may be effected through a large catheter or cystoscopic sheath and application of suction. Irrigation with a solution of boric acid and alum (15 grains to the ounce) is an effective hemostatic. In exceptional cases, transurethral or suprapubic fulguration of the bleeding points may be necessary.

#### NEUROGENIC LESIONS

Intrinsic central nervous system diseases, apart from those resulting from trauma, cause retention of urine. Cord tumors, syringomyelia, myelitis and tabes dorsalis are frequently complicated by urinary retention. Recent advances have been made in demonstrating altered intravesical pressure and muscle tonus in such conditions by cystometric determinations.

In tabes, one must take into account the fact that the patient is also in the age group characterized by prostatic hypertrophy. Both conditions may be present and for this reason catheterization, with judicious emptying of the bladder and use

of antiseptic astringent irrigating solutions, is permissible.

#### POSTOPERATIVE RETENTION

Postoperative retention represents the most common form of reflex inhibition of urination. Individuals upon whom local anesthesia is used are seldom if ever troubled. In contrast, however, spinal or inhalation anesthesia is characteristically followed by acute retention in from 10 to 50 per cent of all cases.

Butureanu and Burghel<sup>4</sup> report a 10 per cent incidence of acute retention after 573 spinal anesthetics, one-third of which were for lower abdominal or pelvic surgery. Jordan,<sup>5</sup> surveying a group of postoperative cases at the University Hospital, Philadelphia, notes an incidence of 19.3 per cent with retention following spinal, 12.5 per cent after ether, and 27 per cent after nitrous oxide-ether anesthesia.

Apparently, impulses which normally initiate the act of micturition are nullified by the anesthetic, resulting in interruption in the coordinated cycle of rhythmic bladder musculature contraction and subsequent relaxation of the sphincter. The failure of the bladder to heed Nature's call with subsequent retention is similar to the production of constipation when the desire to defecate is repeatedly denied. Barrett<sup>6</sup> has made the interesting clinical observation that if catheterization is done before the patient is unduly distended or at the first complaint of discomfort, two-thirds of such cases will be relieved without subsequent discomfort or danger.

Routine postoperative catheterization should be avoided except in certain gynecological operations upon the vagina or perineum, where straining and pressure is contraindicated and where residual urine commonly predisposes to acute infection. Time honored conservative measures include heat to the hypogastrium in the form of an electric pad, hot water bottle or stupes; the sound of running water; oral administration of strychnine or belladonna; subcutaneous injections of pituitrin, ergot

or physostigmine; and methenamine intravenously in 30 to 60 grain doses. Potassium acetate, 15 grains every half hour for eight doses, has been advocated by Jordan to relieve internal sphincter spasm. A warm enema may frequently initiate micturition.

The average patient who has been subjected to surgery can easily go twelve to fourteen hours without catheterization. Some surgeons favor early and repeated catheterization while others absolutely forbid it. Hard and fast rules cannot be laid down but the patient should not be allowed to suffer unduly. In the absence of pain, catheterization is not indicated unless one fears anuria, and wishes to confirm such an impression. If strictest asepsis is observed, the procedure is innocuous. Curtis<sup>7</sup> reports on 1595 major operations in women, 34 per cent of whom required catheterization. In 275 instances where the procedure was done once or twice, none were infected; of 269 requiring relief of retention three times or more, 12 developed cystitis. Jordan's statistics are less impressive, with 9 of 37 cases catheterized developing cystitis and one an epididymitis. Cases of severe fatal urosepsis have been reported by others following simple postoperative catheterization.

As a prophylaxis against postcatheterization cystitis, germicidal solutions of silver nitrate, argyrol, protargol, neosilvol or acriflavine should be instilled into the bladder and urethra as the catheter is being withdrawn. We have found that if patients are urged to void while the catheter is in the bladder, they may force it out and continue with the urinary stream naturally. One may modify this technique by slowly withdrawing the catheter as the patient is told to void with similar gratifying results. The vicious inhibiting mechanism is thus broken and further mechanical withdrawal of urine is rendered unnecessary.

#### OTHER REFLEX PHENOMENA

Apart from reflex inhibition of urination after general or spinal anesthesia and from operations on the urethra, perineum or

rectum, essential sphincterospasm occurs in individuals with vegetative imbalance or psychic conflicts. The desire to void

ovarian cyst or retroverted gravid uterus impacted in the pelvis have been reported as causes of complete urinary obstruction.



FIG. 4. Cystogram depicting the distended viscus which contained 2500 c.c. of urine. (Courtesy Dr. S. R. Woodruff.)

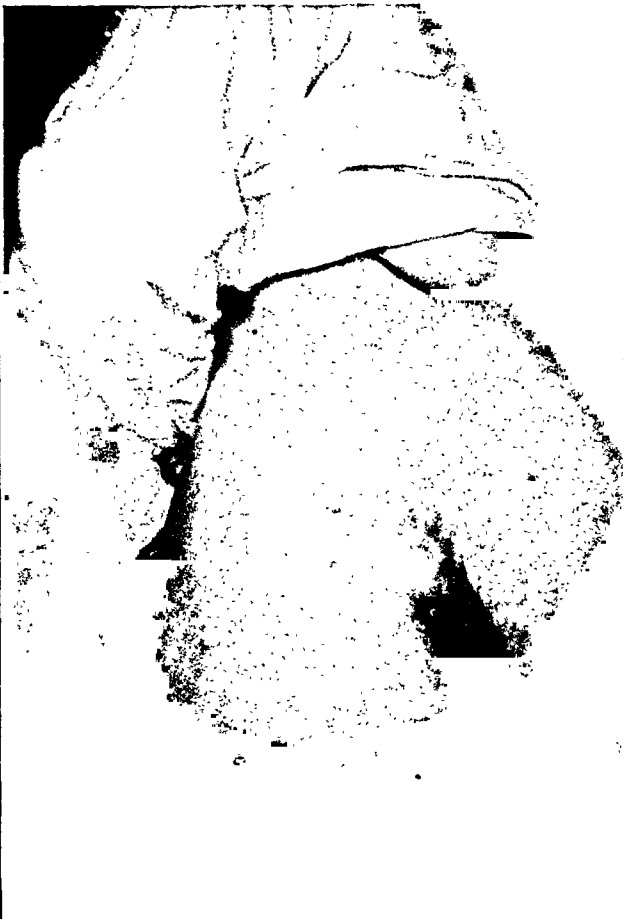


FIG. 5. Lateral view of patient in the acute retention due to hysteria showing marked abdominal protuberance. An abdominal tumor had been suspected prior to catheterization. (Courtesy Dr. S. R. Woodruff.)

which has been denied by circumstance in a perfectly healthy individual may be followed by acute retention of urine.

Hysteria, most often evident in women, may account for single or frequent attacks of retention. No organic pathology can be found in such cases even after thorough urologic investigation. Woodruff<sup>8</sup> recently saw a middle-aged woman with acute retention of over two liters of urine which could only be explained on the basis of hysteria (Figs. 4 and 5). Psychotherapy resulted in no further disturbance. A similar instance was seen by us in a woman who was considerably agitated by business and familial problems.

#### MISCELLANEOUS DISORDERS

Gynecological conditions may occasionally produce acute retention. Uterine fibroid,

Hematocolpos behind an imperforate hymen, pelvic abscess, extreme procidentia, inflammatory edema of an urethral caruncle or even excessive vaginal packing have led to complete mechanical obstruction of urinary flow. Treatment is directed at correction of the cause, catheterization merely alleviating acute distress.

*Vesical or urethral calculi*, by impinging upon the internal or external sphincters or becoming impacted in the urethra can completely block the outflow of urine (Figs. 6 and 7). Urethral calculi may be crushed and removed by foreign body forceps through the panendoscope or pushed back into the bladder and converted into vesical calculi. Occasionally the stone may become so impacted and imbedded in

inflammatory tissue as to warrant external urethrotomy. Vesical calculi may be removed by cystoscopy, litholopaxy or suprapubic cystotomy.

such offenders are belladonna, opium, and cantharides. Valentine and Fitzgerald<sup>9</sup> presented instances of the deleterious effect of ephedrin when used in elderly asthmatics.



FIG. 6. Roentgenogram showing shadow of large calculus. (Bandler and Hyams. *Am. Jour. Surg.*, 8: 836-841, 1930.)

*Rectal lesions* are an indirect source of urinary dysfunction. Reflex inhibition has already been cited. Tumefaction or abscess formation in or about the lower rectal segment can produce sufficient pressure upon the urethra to completely obstruct it. In radical abdominoperineal surgery, sympathetic or sacral nerve roots may be so damaged as to cause persistent urinary retention for weeks or months.

*Foreign bodies* represent an infrequent source of urinary obstruction. Insertion of objects into the urethra for purposes of masturbation may result in their impaction in the channel. Rings, bands, or ligatures may be playfully placed about the penis only to produce edema, constriction, and in extreme cases, actual obstruction. Treatment depends on the nature of the offending agent and the mechanical problem at hand.

*Drugs* have been held accountable for a few cases of acute retention of urine. Among



FIG. 7. Complete urographic study resulting from vesicorenal reflux of 6 per cent sodium iodide solution. This picture was made prior to complete removal of obstruction at internal vesical sphincter. (Bandler and Hyams. *Am. Jour. Surg.*, 8: 836-841, 1930.)

Sphincter spasm, pain and a desire to void out of all proportion to the quantity of urine in the bladder was noted, in addition to red blood cells, albumin and an increased number of epithelial cells in the urine.

Ephedrin stimulates the sympathetic innervation to the sphincter. Systemic signs of toxicity are palpitation, restlessness, gastric pains and giddiness. Removal of the drug is followed by subsidence of symptoms, while its resumption in sensitive cases causes exacerbation. Respect for such individual drug idiosyncrasies represents ideal therapeutics.

#### CONCLUSION

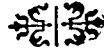
While acute retention of urine and its attendant discomfort represents the imme-

mediate concern of both patient and physician, the latter's responsibility does not end after effecting symptomatic relief. One would be failing in his duty if he did not undertake the task of determining etiological factors involved. In some instances, the cause is readily apparent and needs no further study. On the other hand, urinary disturbance may represent the initial sign of potential or actual pathology.

No attempt has been made to exhaustively enumerate the causes of retention, although the more common and some of the less common etiologic factors have been presented. Many of the therapeutic steps outlined may be carried out in office practice but in some instances hospitalization is desirable, if not imperative.

## REFERENCES

1. WOODRUFF, S. R. and MILBERT, A. H. Congenital atresia of the urethra. Presented before Section on Urology N. Y. Academy of Medicine (Nov.) 1935.
2. BIRDSALL, J. C. Congenital obstruction of the urethra. *Jour. Urol.*, 22: 438, 1929.
3. CREEVY, C. D. Sudden decompression of chronically distended urinary bladder. *Arch. Surg.*, 25: 356, 1932.
4. BUTUREANU, W. and BURGHELE, T. *Presse Méd.*, 35: 1414, 1927.
5. JORDAN, C. G. Postoperative urinary retention. *Ann. Surg.*, 98: 125, 1933.
6. BARRETT, N. R. Treatment of postoperative retention of urine. *Lancet*, 227: 104, 1934.
7. CURTIS, A. H. Management of female bladder after operation and during pregnancy. *J. A. M. A.*, 80: 1126, 1923.
8. WOODRUFF, S. R. Personal communication.
9. VALENTINE, J. J. AND FITZGERALD, J. S. Retention of urine due to ephedrin. *Jour. Urol.*, 34: 314, 1935.





# CIRCUMCISION: SIMPLIFIED ANATOMICAL TECHNIQUE\*

RICHARD TORPIN, M.D.

AUGUSTA, GA.

THE object of this paper is to describe an operation which has the advantage of improving the esthetic results

Figure 1. The point of a third forceps is introduced between the foreskin and the glans; by opening the forceps and rotating

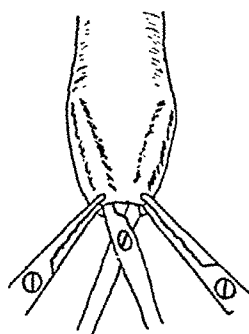


FIG. 1.

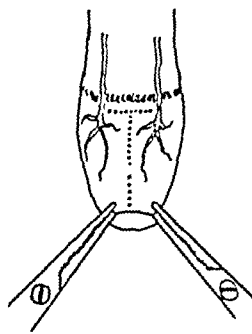


FIG. 2.

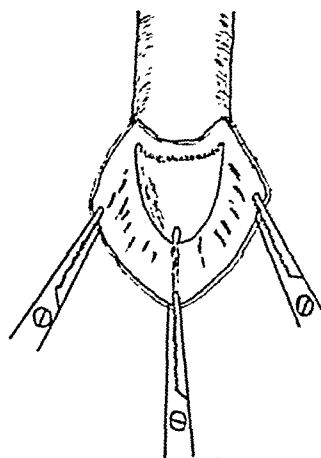


FIG. 3.

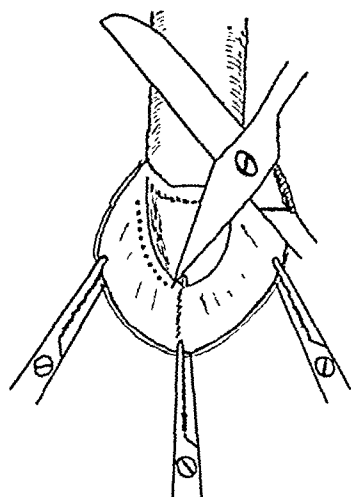


FIG. 4.

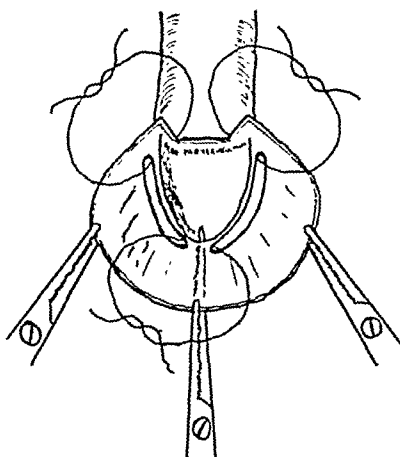


FIG. 5.

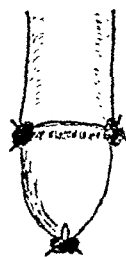


FIG. 6.

following circumcision. The technique is based upon sound anatomic principles, the skin and the mucosa being approximated by the same ligatures used to ligate the three main arteries.

## TECHNIQUE

A mosquito forceps is attached to each side of the tip of the foreskin, as shown in

it on its longitudinal axis the adherent mucosa is separated, as shown also in Figure 1. Then two incisions, a dorsal slit and a lateral incision up to the dorsal arteries, dotted line in Figure 2, are made with scissors. The tip of the frenum is now grasped by forceps and the foreskin laid open as shown in Figure 3. With a sharp point of the open scissors the mucosa and

\* From the department of Obstetrics and Gynecology, University of Georgia School of Medicine, Augusta, Georgia.

the overlying skin are punctured near the frenum at its junction with the glans; then an incision through the mucosa and the skin is made almost up to the dorsal artery on the same side, Figure 4. A like incision is then made on the opposite side. This leaves the foreskin attached at three points, each of which has skin, artery and mucosa; one of these is the frenum, Figure 5. These three bands of tissue are then firmly ligated with silk or linen as shown in Figure 5, and the foreskin excised distally leaving three tags of tissue which dry and separate with the ligatures in three or four days, Figure 6.

The slight plication of the skin and the mucosa which takes place at the site of the ligatures keeps the cut surface of the skin and the mucosa in perfect apposition. Before cutting the ligatures short it is well to retract the skin at the intervening portions and then to tie into the nearest ligature any aberrant bleeding point. In the Norwegian American Hospital, where this procedure is now being used by obstetricians and internes, considerably less postoperative hemorrhage has been noted.

This technique is adapted to obstetric practice but is serviceable in older patients.

The advantages of the operation are as follows: (1) no suturing used; (2) inexpensive ligature material, only a twenty inch strand of silk or linen; (3) few instruments, required; four mosquito forceps and a pair of scissors with one sharp and one dull point; (4) operation completed without assistance in three to five minutes; (5) hemostasis by vessel ligation; (6) ex-

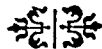
cellent approximation of skin to mucosa with less danger of infection; (7) the ligatures need not be removed; they drop off with the dry tags of tissue in three or four days, and (8) office procedure with little fear of secondary hemorrhage.

#### SUMMARY

This illustrated paper describes a rapid technique for circumcision in infants. Only three or four mosquito forceps and a pair of scissors are used. Ligation of all arteries is done with linen, silk or catgut and the skin is approximated to the mucosa without the use of suturing.

#### REFERENCES

- BERTWISTLE. A plea for standard technic of circumcision. *Lancet*, 1: 85, 1935.  
 BETTMAN. An exact technic for circumcision. *West. Jour. Surg.*, 41: 220, 1933.  
 BRODIE. Office technic of circumcision of adult. *Medical Record*, 141: 534, 1935.  
 CANRIGHT. Simple operative procedure of circumcision. *China Med. Jour.*, 45: 152, 1931.  
 PAUL. New technic of circumcision. *Jour. Ceylon Br. Brit. Med. Assn.*, 26: 45, 1929.  
 SINKOE and ARTEGA. Modern technique for better plastic results. *Urol. and Cutan. Rev.*, 32: 728, 1928.  
 MCWHORTER. Technic of local anesthesia in circumcision. *Surg. Clin.*, 4: 151, 1920.  
 CURTIS. Bloodless new method. *Practitioner*, 97: 101, 1916.  
 MILLSTONE. Bloodless, cosmetically perfect technique. *Med. Rec.*, 92: 680, 1917.  
 TWYMAN. Two V-flap, practical circumcision for children. *Jour. Missouri Med. Assn.*, 14: 59, 1917.  
 CHRISTOPHER. *Minor Surgery*. Ed. 2. Phila., W. B. Saunders Co., 1935, p. 435.  
 FOOTE and LIVINGSTON. *Principle and Practical Minor Surgery*. Ed. 6, Appleton, New York, 1929, p. 480.



# PHYMOSIS AND PARAPHYMOSIS; CIRCUMCISION; DORSAL SLIT; CONSTRICTION OF MALE MEATUS

EDGAR G. BALLENGER, F.A.C.S., M.D., OMAR F. ELDER, M.D. AND  
HAROLD P. McDONALD, M.D.

ATLANTA, GA.

## PHYMOSIS AND PARAPHYMOSIS

**P**HYMOSIS is a constriction of the male meatus in which the prepuce can not readily be retracted back over the glans penis. Mild phymosis rarely gives trouble and the individual may not seek correction unless for hygienic reasons. Marked phymosis or one in which the prepuce cannot be retracted is more likely to present complications such as retained prepuceal secretion, balanitis, benign or specific ulcers, herpes, papillomata, etc.

*Treatment.* The treatment of phymosis depends upon the character and severity of the complications present. Phymosis uncomplicated by infection is best treated by circumcision. Even in the presence of papillomata or simple balanitis circumcision may be done. In removing the prepuce papillomata should be removed also if they are in the area to be removed and may be either fulgurated or cut off at the base if they are in the area not to be removed.

*Paraphymosis.* Upon forcible retraction of a marked phymosis, and in some infections or in case of trauma in the presence of a normally retracted prepuce, paraphymosis may result.

*Treatment.* A simple method often successful in reducing paraphymosis is pressure over the swollen part by wrapping a towel or cloth around the penis and grasping it in the hand. Firm pressure usually will reduce the edema sufficiently to allow the constriction to be pulled back over the glans. Occasionally it is necessary to divide the constricting bands by incision back of the glans. Novocain one per cent is injected and the bands divided. Later circumcision is advisable.

## CIRCUMCISION

Circumcision is carried out under novocain anesthesia in all except young children.

*Technique.* One per cent novocain solution is injected into the subcutaneous area about one-half to two-thirds the way from the glans to the base of the penis. By making a very quick puncture at the first site of injection and injecting ahead of the needle, the injection of novocain can be painlessly done. Other injections are made to complete the circle around the penis always introducing the needle into an area already anesthetized by a previous injection. Another circle of anesthesia is made in a similar manner just back of the corona. When the prepuce cannot be retracted several punctures may be necessary in the skin above the glans to allow an incision in the edge of the prepuce to permit its retraction. After anesthesia is complete the prepuce is drawn forward over the glans and a long straight clamp is applied at an exact point on the skin which is just back of the corona when the prepuce is not drawn forward. The inner part of the prepuce is also drawn tightly through this clamp taking care not to include the glans. The distal portion is cut off with a knife and the clamp removed. If the clamp has been properly applied the removal of more tissue will not be required. If necessary to trim away more tissue this may be done with scissors. The mucous membrane should be left about  $\frac{1}{4}$  to  $\frac{1}{2}$  inch back of the corona. All bleeding vessels are caught and tied with fine catgut. It is important to tie all vessels and even oozing points. The edges of the skin and mucous membrane are then sutured together using a fine 00, ten to twenty day chromic catgut in a continuous suture. The

stitches are placed close to each other and care is taken not to draw the edges too tightly together. Since there is usually more

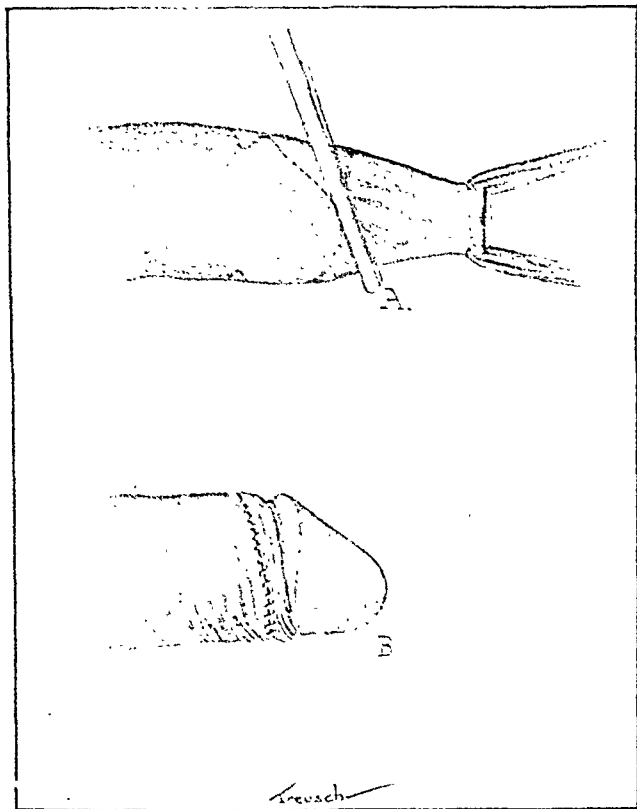


FIG. 1. Circumcision: A, clamp in place before removal of prepuce; B, after suture.

skin than mucous membrane it is important to measure the unsutured part from time to time so as to make the skin and mucous membrane come out even, at times taking the stitches further apart in the skin to make up for this difference. Experience has shown that there are less pain and painful erections after suturing in this manner than after the usual interrupted suture. The cosmetic result afforded is better and healing is prompt. A creamy paste of bismuth salicylate in mineral oil is applied and held in place with a bandage which is replaced in three days. The patient should exercise care not to wet the bandage. Usually the dressing is finally removed in a week or ten days. Tendency to infection or other untoward results have not been noted in over twenty years use of this technique.

#### DORSAL SLIT

In the event of a phymosis complicated by chancroidal or other infection severe

enough to make circumcision not advisable a dorsal slit (Fig. 2) should be done to facilitate treatment of the infection. This

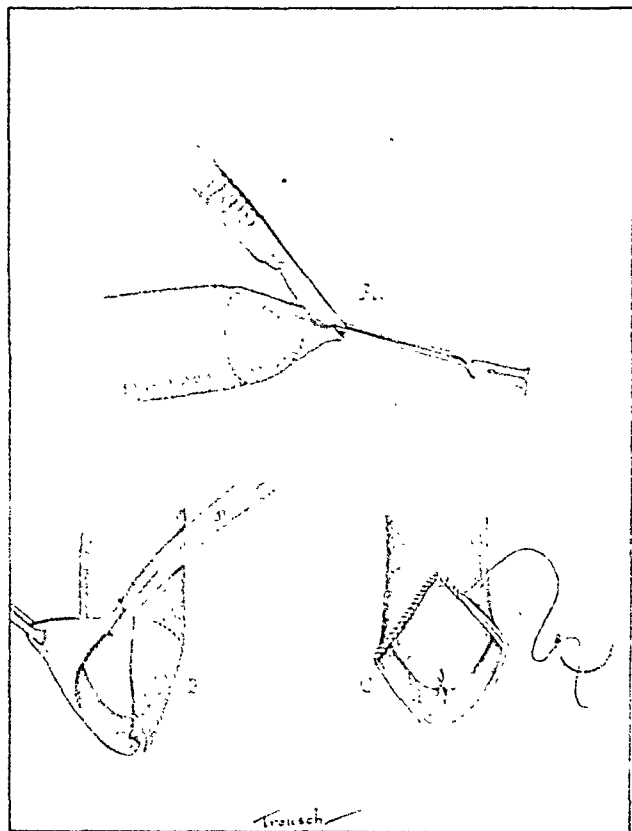


FIG. 2. Dorsal slit; A, incision through prepuce over grooved director; B, trimming away flap on each side; C, suture with continuous suture.

is done under novocain one per cent injected along the prepuce and down to the undersurface of the prepuce. A grooved director as a guide allows the incision to be made without danger of injury to the glans penis. The incision is made on the dorsal side and extended back behind the corona. Removal of a flap on each side at this time makes treatment easier and also facilitates or makes unnecessary circumcision later. The edges should be fulgurated in the presence of a chancroidal or other infection, otherwise the edges are sutured with interrupted or continuous stitches. After the infection has cleared circumcision should be done.

#### CONSTRICTION OF THE MALE MEATUS

A narrow meatus is the cause of many disorders of the urethra and prostate. Non-specific urethritis, irritation in the

## Ballenger et al.—Phymosis

deep urethra, disorders of the sexual function, prolonged gonorrheal infection, and other complaints are frequently caused

wound is greatly facilitated by leaving the ends of the side sutures long and using them as retractors to pull up the mucous

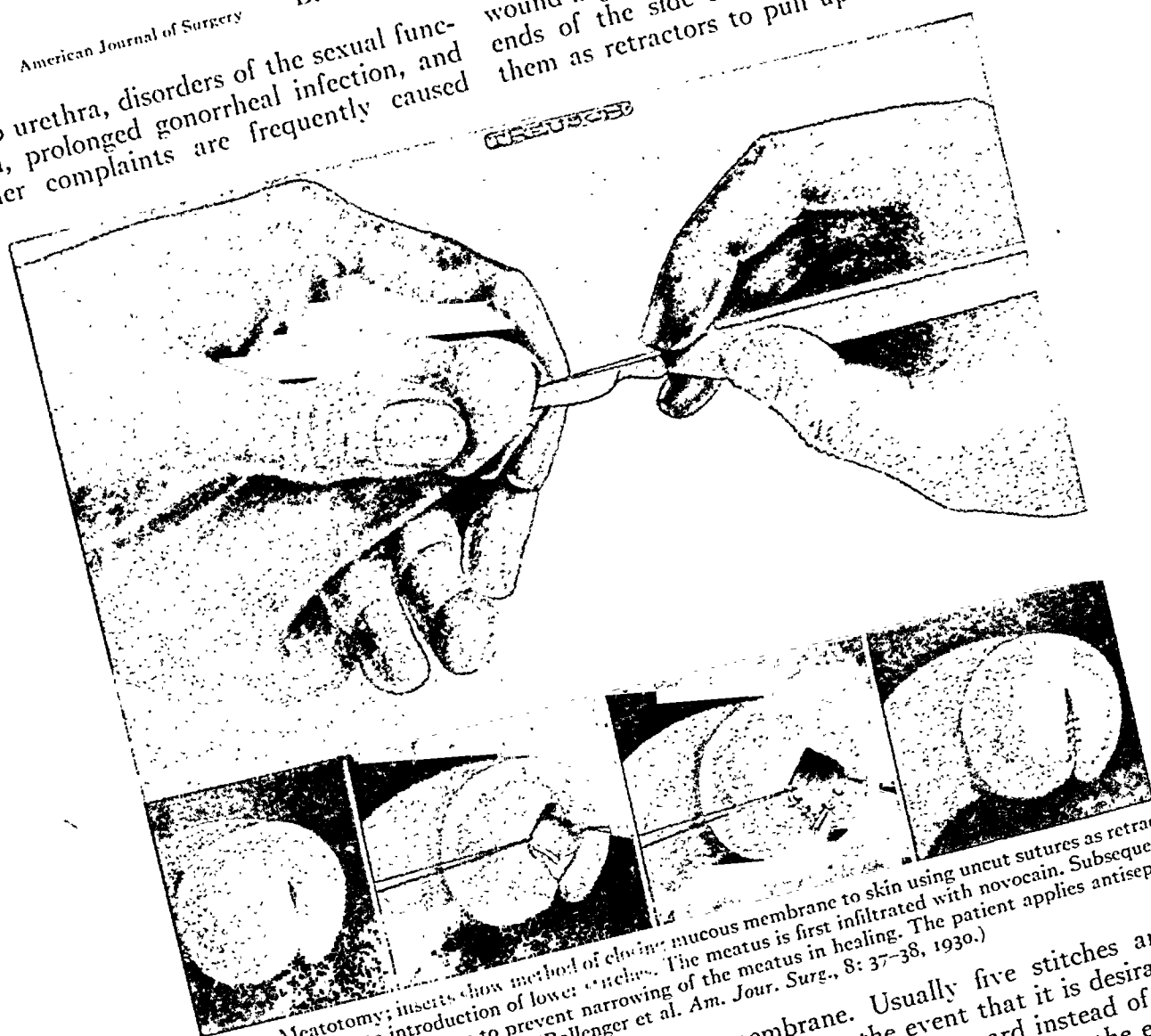


FIG. 3. Meatotomy; inserts show method of closing mucous membrane to skin using uncut sutures as retractors to facilitate introduction of lower catheter. The meatus is first infiltrated with novocain. Subsequent sounding is not necessary to prevent narrowing of the meatus in healing. The patient applies antiseptic solution twice daily for a week. (Ballenger et al. *Am. Jour. Surg.*, 8: 37-38, 1930.)

by a small meatus. When it is 26 F. or less meatotomy should be done.

**Technique.** Anesthesia is obtained by hypodermic injection of one per cent solution of novocain into the lower edge of the meatus. Bleeding from the incised area is lessened by adding one drop of adrenalin chloride to the novocain solution. The meatus is opened to a 32 F. bulb. Using a fine 00 plain catgut the edge of the mucous membrane is then sutured to the skin edge on each side. It is not necessary to pass sounds to prevent subsequent narrowing of the meatus from cicatricial contraction. Taking the stitch in the lower part of the

membrane. Usually five stitches are required. In the event that it is desirable or necessary to cut upward instead of downward it is better to cauterize the edges of the wound with Monsel's solution as the sutures are not as easily placed on the upper part of the glans. Meatotomy with sutures to control hemorrhage and hasten healing gives a better cosmetic result than meatotomy as ordinarily done.

## SUMMARY

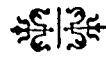
While these affections usually are of minor importance, at times they may produce very serious complications. Individ-

uals in need of circumcision undoubtedly are more likely to contract syphilis and chancroidal infection than are the circumcised. Cancer of the penis is practically never seen except in men who are in need of circumcision and especially is it likely to arise when the foreskin is adherent to the glans penis.

Phymosis which develops secondarily to chancroidal infection may result in extensive destruction of the penis because of the difficulty in applying treatment.

The average doctor does not regard a small meatus as a matter of much concern. Yet it is often the unsuspected cause of non-specific urethritis, irritation of the deep urethra, disorders of the sexual function, prolonged gonorrheal infection, and other complaints.

Meatotomy with sutures to control hemorrhage and hasten healing gives better results than meatotomy as ordinarily done.



# URETHRAL CARUNCLE\*

EDWARD L. KICKHAM, M.D., F.A.C.S.

Instructor, Department of Gynecology, Tufts College Medical School; Visiting Surgeon, Gynecological and Obstetrical Service, Carney Hospital

BOSTON

URETHRAL caruncle or vascular tumor of the meatus is the most common neoplasm of the urethra and was first described by Samuel Sharp in 1750, who said, "Small excrescences may occasion violent disorders in so tender an organ as the urethra." It is known by various other terms such as granuloma, papilloma, angioma and irritable caruncle.

## ANATOMY

The growth practically always appears on the lower half of the meatus, is florid or dusky red in color, and is attached to the urethral margin by either a pedicle or a broad base which may extend into the canal. The appearance varies from flat and rugose and slightly elevated to a narrow tumor with a pedicle and a sharp crenated edge, standing out from the urethra and compressed by the nymphae. It is usually single, but occasionally there may be two or more.

## HISTOLOGY

It is essentially a vascular growth and Skene, who made a special study of urethral neoplasms, applied the term papillary polypoid angioma and described it as a "bunch of dilated capillaries set in moderately dense stroma of connective tissue, covered with mucous membrane which has the usual pavement epithelium." The presence of any unusual number of nerve fibres or unusual arrangement of nerve endings has not been satisfactorily demonstrated although many believe they are well supplied with nerve tissue which accounts in some measure for their extreme sensitiveness.

## ETIOLOGY

The exact cause is not known. It may occur at any age. It is most common just before, during or immediately after the menopause and it is more frequently seen in multiparae. In young women gonorrheal urethritis is thought to be a causative factor, as is inflammation of Skene's ducts. In older women chronic cystitis, cystocele and urethrocele are thought to cause the condition.

## DIAGNOSIS

The diagnosis is usually made by inspection or examination and is obvious. Occasionally the condition is so sensitive that complete examination is not possible and this in itself is a point in favor of the presence of a caruncle.

*Differential Diagnosis.* Urethral caruncle must be distinguished from several conditions found in this region, although the differentiation is usually not very difficult. Urethral polypi which are usually much less sensitive and most often are attached higher in the urethra may at times be confused with caruncle. Prolapse of the urethra is another condition which occurs in this region, but the principal point of difference is that the prolapse involves the entire circumference of the meatus while the caruncle is most always on the lower half and a small part of that. Inflammation of Skene's ducts usually does not cause painful micturition which is an almost constant symptom of caruncle. Also, the gland openings can usually be seen and pus may be expressed from them. Cancer at this point is very rare, but patho-

\* The Department of Gynecology, Tufts College Medical School and the Gynecological and Obstetrical Service, Carney Hospital, Boston, Mass.

logical examination of the excised tumor will assure the diagnosis and proper follow-up treatment may be instituted without any harm having been done either by trauma or delay.

#### CLINICAL HISTORY

The principal symptom is pain. It may take the form of painful micturition, either slight or severe. Dyspareunia is a common symptom, with consequent upset of the nervous system. Pressure on walking or sitting and especially pressure from clothing or sanitary pads are frequent complaints. Occasionally, retention of urine for long periods is noted and this is brought on gradually by the individual in her attempt to avoid painful micturition. Hemorrhages may occur when the vessels are near the surface and these may vary from slight staining to bleeding of alarming proportions, especially when they are recurrent. In extreme cases the constant pain and discomfort may cause irritableness, despondency, loss of appetite, loss of weight, loss of sleep and sometimes leads to severe nervous upsets, the cause of which is many times completely overlooked. Frequency of micturition without pain is found in the occasional case but to be without pain is very rare.

#### TREATMENT

Various forms of treatment have been used with varied success. One author advocates the removal of the tumor with a scissors and suturing the base. He contends that removal by cautery is unreliable, causes unnecessary destruction of tissue and promotes the formation of uncontrollable scar tissue. Another maintains that the procedure should be entirely surgical, with free excision of the entire base and the wound closed with sutures. Still another is of the opinion that simple excision is followed by a large percentage of recurrences and that removal by a small tip cautery is followed by the largest proportion of permanent cures. Kelly advises

complete extirpation, preferably by electrodesiccation or electrocoagulation of the base. The treatment we advise and have found to be uniformly successful in uncomplicated cases is a combination of both surgical excision and the cautery.

*Technique.* Under surgical anesthesia a semicircular incision is made along the margin of the meatus about the tumor. We make sure that this incision is wide enough to include the base of the tumor and deep enough to include the full thickness of the mucous membrane. The growth is then excised and the base is coagulated with a fine tip cautery. Very rarely are sutures used in the entire procedure, although they may be used at the angles for approximation of the cut edges. Care must be exercised in the use of the cautery in order to avoid injuring the surface epithelium thereby causing a troublesome scar. If the cautery is confined to the base of the tumor which is below the mucous membrane, the surface pavement epithelium will heal uneventfully and recurrence is rare.

#### PROGNOSIS

The prognosis is not always hopeful, especially in recurrent cases. Many of these tumors are very stubborn and reformation is likely to occur with the consequent deformity of the orifice by repeated partial operations. In primary cases, with complete excision and cauterization of the base the cure is complete in practically every case in our experience.

#### SUMMARY

First, I would again call attention to the frequency of the condition, especially in women of middle age or older;

Secondly, to the necessity for inspection and examination of patients who complain of urinary symptoms; and

Thirdly, to the importance of surgical treatment in the beginning, as the chance of cure with palliative treatment is slight.



# TREATMENT OF SPECIFIC URETHRITIS—NEW MODALITY\*

ALVIN C. DRUMMOND, M.D.

Instructor in Urology, New York Post Graduate Hospital, Columbia University; Chief of Clinic, Gouverneur Hospital; Adjunct Visiting Urologist, Department of Correction, New York City

NEW YORK

I AM presenting, as a preliminary report, the results obtained by treating a number of cases of chronic and acute specific urethritis, both with and without joint involvement, with large doses of the gonorrheal vaccine supplied by the Department of Health, New York City, regulated according to individual reaction, in concentrations of one to five billion gonococci per cubic centimeter. I believe that the beneficial end-result is due to a sufficient dose to produce a bacterial protein shock, which is probably specific and not necessarily due to the specific organisms. The city vaccine contains seven strains (Torey) of organisms and hence seven types of bacterial protein, and the massive dosage of these varying proteins or the combination of the organisms and their proteins may account for the more satisfactory results as opposed to those obtained by non-specific proteins such as milk or proprietary preparations.

How immunity is produced by the vaccine is a disputed question. It has been known for some time that the histiocytic elements in the skin can be stimulated both by specific and non-specific proteins. In the vaccine we may have a soluble specific protein that is directly and to all appearances easily engulfed by the histiocytic cells. The result is the formation of a specific antibody which is available to battle the infection produced by the gonococcus, regardless of the part of the body in which it may localize. This specific antibody accumulation is amply demonstrated by the complement fixation test for gonorrhea. Generally, in the first stages of the infection, the complement fixation reaction may be negative but after the disease has run

its course, either treated or untreated, the complement fixation test may be positive.

Up to the present time, no literature or data are available on the treatment of gonorrhea by massive dosage of gonococcus vaccine. The vaccine is distributed in a concentration of five billion gonococci per cubic centimeter by demand, and the dosage is determined by the physician making the request.

About five years ago, the use of gonococcus vaccine intradermally in concentrations of 250,000,000 per c.c. in cases of specific urethritis was started in the Genito-Urinary Clinic at the Harlem Hospital. The initial dose was 0.10 c.c., increasing to 0.50 c.c., never any higher. The results were negligible. At the present time, concentrations of 250,000,000 gonococci per c.c. are used intravenously at this clinic for the treatment of acute epididymitis; 0.125 c.c. are given as an initial dose, and is followed by 0.25 and 0.50 respectively at weekly intervals. They report that within from one to three hours after the injection of the vaccine the patient has chills, temperature and general malaise. The epididymitis subsides satisfactorily by this method of treatment.

In the out-patient department of our clinic at Gouverneur Hospital, many chronic discharging patients had been treated by the recognized methods for many months without success. Several of these cases were given an initial dose of 0.2 c.c. of the five billion concentration of the City gonorrheal vaccine subcutaneously in alternate thighs. Each injection was increased by sufficient dosage twice each week until a considerable reaction accompanied by chills and fever was obtained. It was noted

\* From the Department of Urology, Gouverneur Hospital, New York City, Joseph A. Hyams, Director.

that the initial dose of 0.2 c.c. produced erythematous areas which varied in extent with each individual, but generally speaking, when the dosage had reached 1 c.c. and above, there was no increase of the size of the area of erythema, although there seemed to be an involvement of the deeper structures, judging from increased tenderness. This was further evidenced by heat, tenderness, and a red blotching discoloration at the site of injection.

These larger doses proved to be somewhat disabling for a period of one to four days. The initial reaction occurred from three to six hours after the injection. The patient complained of hypersensitivity to extraneous objects such as clothing, and an intense itching of the skin area involved. Immediately upon getting the "major shock" manifested by temperature from  $102^{\circ}$ – $104^{\circ}$ ; headache, chills and general malaise, the patient noted cessation of the discharge twelve to twenty-four hours later. It may be that the temperature produced attenuates the gonococcus in a manner similar to the various forms of heat therapy now in vogue. The urine became clear in both glasses, with only an occasional shred in the first one. After the discharge ceased, there was no continuation of the morning drop. It has been a question in my mind whether the long continued morning drop might not be the result of the frequent self-administered instillations, giving rise to a chemical and secondary urethritis. In conjunction with this treatment, we have prescribed routinely acriflavine 1:5000 dilution as a hand injection for the patient. No other medication was used.

#### DISCUSSION

Twenty-eight cases of gonorrheal urethritis are presented which were treated by means of varying doses of gonorrheal vaccine. This procedure was instituted in an effort to cure the large number of chronic discharging cases of long standing which did not respond to the ordinary methods of treatment. In this group (Table 1), how-

ever, are included several cases of specific urethritis who came under our observation at the end of the usual incubation period. These acute cases demonstrate the effectiveness of the vaccine therapy early in the course of the disease. Because of the types of patients treated and because of the long-standing practice of prescribing some type of medication for the urethra, it was thought advisable, merely for uniformity of results, that the patient be given a bland and rather innocuous solution for self-instillation. This was neutral acriflavine in dilution of 1:5000 for use once each day. This proved effective in preventing the patient from obtaining more drastic medication elsewhere. For purposes of comparison and control, another group of cases treated with various instillations are included in Table 11, and in Table 111 a group treated with vaccine alone.

It is my belief that the rather startling results obtained in this series were due to the various bacterial proteins found in the vaccine and not to the specific organisms. I have no way of proving this statement.

The largest single injection of vaccine given in this series, which caused the "major shock" was 11 c.c., and this patient (No. 10 in the table) received a total of 64.5 c.c. of vaccine. Prior to the institution of vaccine therapy, the patient had lost forty-five pounds in weight, and being of slender build, he offered a pathetic picture. The chronicity of this case had become so desperate and the discharge prior to the vaccine shock so profuse that it was thought that a stricture of the urethra had developed but careful calibration of the canal revealed no constriction of the urethra. Shortly after the discharge ceased at the end of seventy-seven days, he gained twenty-seven pounds. The urine became perfectly clear with only an occasional shred, and there has been no recurrence of the previous manifestations. It is striking that in all of these 28 cases, once having secured a true bacterial protein shock, the annoying and chronic morning discharge which had persisted under the ordinary

TABLE I

| Case Number.....   | 1                         | 2                            | 3   | 4  | 5                                  | 6                 | 7  | 8   | 9  | 10  | 11                                   | 12                                   | 13                | 14  |
|--|---------------------------|------------------------------|---|--|------------------------------------|-------------------|--|---|--|---|--------------------------------------|--------------------------------------|-------------------|---|
| Time between discharge and exposure.....                           | 7 days                    | 14 days                      | ?   | 10 days  | 0                                  | 7 days            | 10 days  | 7 days  | 7 days   | 7 days  | 10 days                              | 7 days                               | 7 days            | ?   |
| Previous attacks of gonorrhea                                      | No                        | No                           | 4 times   | No   | No                                 | 3 times           | No   | 1 time  | No   | No  | 1 time                               | No                                   | No                | 1 time (20 yrs.)                              |
| Smear.....   | Positive                  | Positive                     | Positive  | Positive   | See remarks                        | Positive          | Positive   | Positive  | Positive   | Positive  | Positive                             | Positive                             | Positive          | Positive                                      |
| Number of days of discharge before 1st visit.....                  | 6 days                    | 10 days                      | ?   | 31 days  | 0                                  | 4 days            | 7 days   | 12 days   | 40 days  | 33 days   | 21 days                              | 21 days                              | 1 day             | 35 days                                       |
| Initial dose of vaccine.....                                       | 0.2 cc                    | 0.2 cc                       | 0.2 cc  | 1.0 cc   | 0.2 cc                             | 0.2 cc            | 2.0 cc   | 0.5 cc.   | 0.2 cc   | 2.0 cc  | 0.2 cc                               | 0.2 cc                               | 0.2 cc            | 1.0 cc  |
| Reaction:  | 0.2-x<br>1.0-x<br>2.0-xxx | 0.2-x<br>1.0-xxxx<br>3.0-xxx | 0.2-0<br>1.0-x<br>2.0-x<br>2.5-x<br>3.5-x<br>4.0-x<br>4.5-x<br>5.5-x<br>7.0-xx<br>8.0-xxx | 1.0-x<br>1.5-x<br>2.5-x<br>3.5-x<br>4.0-x<br>6.0-xxx | 0.2-0<br>2.0-x<br>3.0-x<br>4.0-xxx | 0.2-xx<br>1.0-xxx | 2.0-0<br>3.0-0<br>4.0-x<br>5.0-x<br>6.0-x<br>7.0-xxx | 0.5-0<br>1.0-x<br>1.5-x<br>2.0-x<br>3.0-x<br>3.5-x<br>4.0-x<br>4.5-x<br>5.0-x<br>5.5-xx<br>6.0-xxx<br>7.0-xxx | 0.2-x<br>1.0-x<br>2.0-xx<br>3.0-xxx<br>4.0-xxx<br>5.0-xx | 2.0-0<br>2.0-x<br>3.0-x<br>4.0-x<br>5.0-x<br>6.0-x<br>6.5-x<br>8.0-x<br>9.0-x<br>10.0-x<br>11.0-xxx | 0.2-0<br>2.0-x<br>4.0-xxx<br>5.0-xxx | 0.2-0<br>1.0-0<br>3.0-xxx<br>4.0-xxx | 0.2-xx<br>1.0-xxx | 1.0-0<br>2.0-x<br>4.0-xx<br>5.0-xx<br>6.0-xxx |
| Total amount of vaccine given before major shock                   | 4.2 cc                    | 4.2 cc                       | 27.2 cc   | 17.5 cc  | 9.2 cc                             | 1.2 cc            | 25.2 cc  | 51 cc   | 16.5 cc  | 64.5 cc   | 11.2 cc                              | 8.2 cc                               | 1.2 cc            | 19 cc   |
| Time elapsing before discharge ceased after vaccine was given..... | 9 days                    | 7 days                       | 12 days   | 14 days  | 22 days                            | 5 days            | 24 days  | 56 days   | 7 days   | 14 days   | 10 days                              | 10 days                              | 6 days            | 3 days  |
| Complement fixation.....   | Positive                  | Positive                     | Positive  | Positive   | Positive                           | Positive          | Positive   | Positive  | Positive   | Positive  | Positive                             | Positive                             | Not taken         | Positive                                      |
| Recurrence of symptoms   | No                        | Yes, see rem'ks.             | No  | No   | No                                 | No                | No   | Yes   | Yes  | No  | No                                   | No                                   | No                | No  |
| Joint involvement...   | No                        | No                           | No  | No   | No                                 | No                | No   | Yes   | No   | No  | No                                   | No                                   | No                | No  |
| Acute epididymitis...  | No                        | Yes                          | No  | No   | No                                 | No                | Yes  | No  | No   | No  | No                                   | No                                   | No                | Yes   |
| Time urine became clear.....                                       |                           | 7th day                      | 42nd day  | 14th day   | 45th day                           | 5th day           | 24th day   | 56th day  | 24th day   | 14th day  | 27th day                             | 25th day                             | 16th day          | 15th day                                      |

TABLE I (Continued)

| Case Number.....                     | 1                                      | 2   | 3   | 4   | 5  | 6  | 7   | 8   | 9  | 10  | 11   | 12   | 13   | 14   |
|--------------------------------------|--|---|---|---|--|--|---|---|--|---|--|--|--|--|
| Number of days of the discharge..... | 6 days                                 | 7 days  | 42 days   | 40 days   | 35 days  | 44 days  | 44 days   | 98 days   | 15 days  | 77 days   | 31 days  | 31 days  | 6 days   | 38 days  |
| Disposition of case                  | Under observation                      | Discharged  | Under observation                                       | Discharged  | Discharged   | Discharged   | Discharged  | Discharged  | Under observation  | Discharged  | Discharged   | Discharged   | Discharged   | Discharged   |
| Remarks.....                         | Received major shock with 2 cc vaccine | Pain in testicle relieved by calcium gluconate to per cent. Had inguinal swelling. Frei test negative. Had recurrent discharge which cleared after major shock of 3 cc vaccine. | Patient had intercourse several times during treatment. | Thick yellow low chronic discharge treated with intrastillations and syringing by patient 30 days. Had knee and right shoulder involvement. | Smear on admission was doubtful. Positive 7 days after initial visit. Treated by ordinary methods 1st 20 days. | Severe reaction following injection. (Herpes, chills, fever—104, in bed 4 days.) Also undergoing treatment for lues. | Treated Bellevue before admission for acute epididymitis. Treated here with calcium gluconate 10 per cent and intrastillations without benefit. Treated 33 days before vaccine therapy was started. | Had 42 days of treatment elsewhere where mainly auto-injections. When seen discharge profuse, thick yellow. Joint involvement. Calcium gluconate 10 per cent. | With 3 cc temp. 102° general disability. 4 cc. made for shock. No symptoms for 10 days. Then recurrent discharge cloudy urine, 4.5 cc vaccine produced major reaction. In bed 3 days. Temp. 104 discharge ceased. Admits use of pepper and vinegar 10 days before. | 1st 7 days ordinary methods without results. Discharge profuse, urine cloudy with shreds. After major shock discharge watery and ceased. Urine hazy then clear. | Here again discharge ceased before urine became clear. Major shock occurred with an additional 1 cc (2nd) and urine cleared. | Discharge ceased before urine cleared. Urine remained hazy for 11 days before clearing after last dose of vaccine. | Shock sufficient to stop discharge. Only 1.2 cc vaccine. | Patient to clinic after 5 weeks of discharge. After 6 cc vaccine received typical shock. Discharge disappeared as likewise did the epididymitis. |

Case Number.....

[illegible]

methods has not been found, with a single exception.

Patient No. 8 had one of the most persistent and devastating cases of gonorrhea that has come under my observation. He had had a discharge for forty-two days before coming to the clinic. He was pale, decidedly underweight, and suffering from multiple joint pains. There was an almost continuous flow of thick yellow discharge. He received his "major shock" after a dosage of 7 c.c. of vaccine or a total of 51 c.c. He has been followed for approximately three months since and there has been no recurrence of the joint pain or discharge. The urine is clear.

Cases Nos. 2 and 7 had acute epididymitis when they applied to the clinic for treatment. The only case of acute epididymitis which developed in any patient while under treatment was No. 14, which can be attributed directly to the over-zealous administration of a remedy purchased outside the clinic.

The one case of recurrent discharge is patient No. 9, and he received, before definite improvement resulted, three "major protein shocks"; the first with 3 c.c., the second with 4 c.c., and the third with 4.5 c.c. of vaccine. The discharge ceased after the 3 c.c. injection, but the urine remained cloudy. The urine became clear after the 4.5 c.c. injection, and the thin recurrent discharge disappeared. Questioning revealed that in the interum between the first cessation of the discharge and the last, he had partaken of a rather large amount of spiced vinegar.

It will be noted that those patients who came in at the end of the incubation period with discharge required comparatively small doses of vaccine to secure the "major shock," and that in but one of these cases has there been a recurrence of discharge. In cases Nos. 1, 2, 6, and 13 the average duration of discharge after vaccine therapy was 7.7 days; and in case No. 6, it was only four days. The economic factor here is of importance, at least to the patient.

Another thing which is revealed by this series of cases is that, usually, the discharge

stops before the urine clears, although in some cases the urine and discharge stop simultaneously. In those cases where the urine remains hazy and the discharge has ceased, a second prophylactic dose of vaccine is necessary, which may be the same or slightly larger than the initial one used to secure the "major shock." The urine usually clears after the second shock.

The quantity of vaccine tolerated before the bacterial protein shock occurs, varies with each patient. Further experiments have shown that having once received the shock with a given dose, if it is necessary to repeat the injection, a second shock is invariably experienced by injection of the same amount of vaccine, or an increase in dosage limited to only tenths of a cubic centimeter. In the acute type of case, far smaller dosage is required to secure the "major shock" than in the latter stages of the disease. I believe that our previous failure with gonorrheal vaccine has been largely due to our timidity in giving adequate dosages. My experience leads me to believe that similar results may be obtained by the intravenous administration of the vaccine if the amount is increased sufficiently to produce a maximum reaction.

In no case have we experienced any complications such as abscesses at the site of the injection. It has been our practice to give the injection in alternate thighs, and it is less disabling if injected in the mid-anterior region of the thigh. On one or two occasions, the reaction has been severe enough to cause marked swelling of the thigh.

When the "major shock" is experienced, it is accompanied by two or three days of more or less disability. However, despite the reaction, these patients appreciate the disappearance of the profuse chronic discharge and subsidence of symptoms which in some instances have persisted for ninety days, as well as their improved physical condition. They feel that any reaction and disability is far outweighed by the final result.

I believe that in the treatment of gonorrhea we must never lose sight of the fact

TABLE III

TABLE III

| Case No.  | 613993   | 68998   | 632038   | 612767   | 587832  | 63848   | 68543                               | 612862  | 632768  | 630637   | 66736  | 25546  | 21881   | 37288   |   |
|---|--|---|--|--|---|---|-------------------------------------|---|---|--|--|--|---|---|---|
| Time between discharge and exposure                 | 10 days  | 10 days   | 7 days   | 10 days  | 3 weeks   | 1 week  | 10 days                             | 7 days  | 10 days   | 7 days   | 14 days  | 7 days   | 7 days  | 10 days   |   |
| Previous attack of gonorrhea                        | No   | Yes—3 mo. ago   | No   | No   | No  | No  | No                                  | No  | 1 time  | 1 time—2 mo. ago                                     | 4 times  | 2 times  | No  | No  |   |
| Sugar   | Positive   | Positive  | Positive   | Positive   | Positive  | Positive  | Positive                            | Positive  | Positive  | Positive   | Positive   | Positive   | Positive  | Positive  |   |
| Number days of discharge before 1st visit           | 2 days   | ?   | 1 day  | 3 days   | 3 days  | ?   | 3 weeks                             | 4 weeks   | 4 months  | 7 days   | 10 days  | 7 days   | 7 days  | 3 weeks   |   |
| Initial dose of vaccine                             | 0.2 cc   | 0.2 cc  | 0.2 cc   | 0.2 cc   | 0.2 cc  | 0.2 cc  | 0.1 cc                              | 0.2 cc  | 0.2 cc  | 0.2 cc   | 0.2 cc   | 0.2 cc   | 0.2 cc  | 0.2 cc  |   |
| Reaction:   | 0.2 cc—x<br>1.0 cc—xxx<br>1.0 cc—xxx<br>1.5 cc—xxxx<br>xxx—Moderate<br>xxx—Major | 0.2 cc—xxxx<br>1.0 cc—xxxx<br>1.0 cc—xxx<br>2.0 cc—xxxx<br>4.0 cc—xx<br>3.5 cc—xx<br>3.6 cc—x | 0.2 cc—x<br>1.0 cc—xx<br>1.0 cc—xxx<br>2.0 cc—xxxx               | 0.2 cc—x<br>1.0 cc—xx<br>2.0 cc—xx<br>3.0 cc—xxxx        | 0.2 cc—x<br>1.0 cc—xxx<br>1.0 cc—xx<br>1.5 cc—xxx                 | 0.2 cc—0<br>1.0 cc—xxxx<br>1.0 cc—xx<br>3.0 cc—xxxx                     | 1.0 cc—0<br>2.0 cc—xx<br>3.0 cc—xxx | 0.2 cc—xxx<br>1.0 cc—xxxx<br>1.0 cc—xx<br>2.0 cc—xxxx | 0.2 cc—0<br>1.0 cc—xx<br>1.0 cc—xx<br>2.0 cc—xxxx | 0.2 cc—xx<br>1.0 cc—xxx<br>1.0 cc—xxx<br>2.0 cc—xxxx | 0.2 cc—xx<br>1.0 cc—xxx<br>1.0 cc—xxx<br>2.0 cc—xxxx | 0.2 cc—xx<br>1.0 cc—xx<br>1.0 cc—xx<br>2.0 cc—xxxx | 0.2 cc—x<br>1.0 cc—xx<br>1.0 cc—xx<br>2.0 cc—xxxx | 0.2 cc—0<br>1.0 cc—x<br>2.0 cc—xxx<br>2.0 cc—xxxx                 | 0.2 cc—0<br>1.0 cc—x<br>2.0 cc—xxx<br>2.0 cc—xxxx |
| Total amount of vaccine given                       | 3.7 cc   | 20.8 cc   | 3.2 cc   | 6.2 cc   | 3.7 cc  | 1.2 cc  | 6.0 cc                              | 1.2 cc  | 3.2 cc  | 1.2 cc   | 3.2 cc   | 3.2 cc   | 3.2 cc  | 5.2 cc  |   |
| Total amount of vaccine given before major shock    | 3.7 cc   | 3.2 cc  | 3.2 cc   | 6.2 cc   | 1.2 cc  | 1.2 cc  | 6.0 cc                              | 1.2 cc  | 3.2 cc  | 1.2 cc   | 3.2 cc   | 3.2 cc   | 3.2 cc  | 5.2 cc  |   |
| Number of days discharge ceased after vaccine given | 6 days   | 172 days  | 10 days  | 14 days  | 12 days   | 3 days  | 12 days                             | 3 days  | 14 days   | 12 days  | 12 days  | 10 days  | 5 days  | 5 days  |   |
| Complement fixation                                 | Positive   | Positive  | Positive   | Positive   | Positive  | Positive  | Positive                            | Positive  | Positive  | Positive   | Positive   | Positive   | Positive  | Positive  |   |
| Recurrence of symptoms                              | No   | Yes—see remarks   | No   | No   | No  | No  | No                                  | No  | No  | No   | No   | No   | No  | No  |   |
| Joint involvement                                   | No   | Yes   | No   | No   | No  | No  | No                                  | No  | No  | No   | No   | No   | No  | No  |   |
| Acute epididymitis                                  | No   | No  | No   | No   | No  | No  | No                                  | See remarks   | No  | No   | No   | No   | No  | See remarks   |   |
| Time urine became clear                             | 12th day   | 7th day   | 2nd day  | 9th day  | 14th day  | 5th day   | 5th day                             | 5th day   | 14th day  | 12th day   | 12th day   | 18th day   | 16th day  | 5th day   |   |
| Disposition of case                                 | Discharged no symptoms   | Improved  | Discharged no symptoms   | Discharged no symptoms                                   | Discharged no symptoms  | Discharged no symptoms  | Discharged no symptoms              | Under observation                                     | Discharged no symptoms                            | Discharged no symptoms                               | Discharged no symptoms                               | Under observation                                  | Discharged no symptoms                            | Discharged no symptoms  |   |
| Remarks   | Peri-urethral abscess on admission which was opened 8                            | Patient first seen May 20th. Had had discharge for 3 months which he                          | Discharge with burning 2 weeks before coming in. Major shock ac- | O of sand-wood for burning on Sod. Bicarb. 1 tsp. b.i.d. | Acute prostatitis when first seen; rapidly subsided under vaccine | Purulent discharge on admission; pain in left testicle. Swelling of the |                                     |   |   |  | Urine clear and no discharge after the 12th day      | No symptoms  |   | Had swollen left testicle which subsided after the "major shock." |   |

day later.  
No discharge after 15 days from urethra or abscess.

treated himself. Walked with cane, joint involvement right foot, hands, neck. Right great toe that he is unable to wear shoe. Following injection swelling became so reduced that he was able to wear shoe 30 days after instigating treatment. Swelling of left hand remained. Unchanged. The 4 cc dose of vaccine was followed by temperature (103.2° F). chills, herpes. 24 hrs. later there was marked improvement of both foot and hand. Three months later patient walks without cane and is entirely free from pain.

complicated by chills, fever. In bed 5 days. Slight discharge reoccurs after par-taking seasoned food. This with last 1.5 cc dose of vaccine.

therapy  
Sitz  
baths.  
Home  
condi-  
tions pre-  
vented  
self treat-  
ment.

right in-  
guinal re-  
gion  
which  
has sub-  
sided.



that it is a general systemic disease, just as is any bacterial invading disease. When treating gonorrhea, we are apt to focus our attention on the urethra, and lose sight of the fact that we are treating a general condition.

### CONCLUSIONS

1. There are presented 28 cases of specific urethritis effectively treated with massive doses of gonorrheal vaccine.

2. The evidence seems to show that each patient builds up an antibody immunity during the course of his disease.

3. Consequently, patients longer in the course of their disease require larger doses of the vaccine to secure the described bacterial protein shock.

4. Patients seen at the close of their incubation period require far smaller doses to secure a satisfactory result.

5. The author believes that the results are obtained from the bacterial protein

and their antibodies rather than from the microorganisms.

6. The success of this treatment depends upon the judgment of the physician, whose experience is gained by the observation of a large number of patients.

### REFERENCES

1. BARRINGER, E. D. The treatment of gonorrhea in the female. *J. A. M. A.*, 103: 1825-1828, 1934.
2. CUMMINGS, R. E. and BURHAN, R. A. Experiences with gonococcus filtrate. (Corbus Ferry) and other forms of intradermal therapy. *J. A. M. A.*, 104: 181-186, 1935.
3. BRUNET, M. M. and LEVIN, B. S. *Am. Jour. Obst. and Gynec.*, 28: 501-510, 1934.
4. GERNIN, J. T. Bacteriophagic lysins. *Urolog. and Cutan. Rev.*, 38: 795-798, 1934.
5. RAHLIVES, G. G. Gonococcus vaccine. *Med. Welt.*, 8: 1228-1231, 1934.
6. SOMMER, S. Intracutaneous administration of living vaccine in women. *Monatschr. f. Geburtsch. u. Gynäk.*, 97: 339-348, 1934.
7. SCHULTZ, W. S. Living vaccine. *Central f. Gynäk.*, 59: 306-310, 1935.



# DIAGNOSIS AND TREATMENT OF STRICTURE OF MALE URETHRA\*

JOSEPH A. HYAMS, M.D., F.A.C.S.

Associate Professor of Urology, New York Post Graduate Medical School and Hospital, Columbia University

NEW YORK CITY

THERE has been a notable decrease in the incidence and severity of stricture of the urethra in the past few decades, particularly of the inflammatory type. On the other hand, owing to the hazards of our more complex existence, traumatic strictures have increased. The grave sequels seen in former years have been reduced, due to a better knowledge of urethritis and injuries of the urethra, improved diagnostic measures and more conservative treatment. However, it is not uncommon in practice and the more severe types are still comparatively frequent in our municipal clinics and hospitals. With improved prophylactic measures and the routine roentgenographic delineation of the urethra and its adnexa, further progress is inevitable.

Stricture of the urethra is an abnormal narrowing or loss of dilatability of the urethral lumen. It may occur in either sex, but is more serious in the male. It is difficult to say just what constitutes an atypical reduction in the caliber of the canal, for the normal areas of narrowing may be markedly accentuated without causing urinary disturbance unless infection takes place, a small calculus becomes lodged in the urethra, or the introduction of large sized instruments is necessary (Fig. 1).

They may be temporary or permanent, and the accepted classification is as follows:

Spasmodic;  
Congenital;  
Acquired { Traumatic  
              Inflammatory.

For the diagnosis and treatment of the varied types of stricture, urethrocystography, the roentgenographic delineation

of the urethra and bladder with the use of an innocuous contrast medium is invaluable, either used alone or as a complement to other methods. It gives a visual demonstration of chronic pathological lesions of the urethra and its adnexa. Temporary or permanent narrowings and their differentiation from other lesions can be defined with clearness; while instrumental investigations serve to locate and determine the extent, number and size of the areas of constriction, they fail to give the information as accurately and completely as urethrocystography. Cystourethroscopic examination shows surface changes in the urethra, but urethrocystography also delineates subsurface changes of the urethra, glandular adnexa and the bladder. This simple and practical diagnostic procedure has been described in a previous communication.

Spasmodic stricture is due to spasm of the investing muscles rather than organic change. It may be caused by acute or chronic inflammation of the prostatic urethra, nervousness of the patient or rough instrumentation (Fig. 2). It is often associated with inflammatory stricture, particularly when the prostatic portion is affected. It may be diagnosed by instrumental methods similar to those used to determine other types, or by urethrocystography. The treatment is based on removal of the underlying cause. Palliative measures consist of local application of heat, sedatives and anti-spasmodics and catheterization if necessary, for the prevention of an overdistended bladder.

Congenital constriction at the meatus is more frequent than any other type. It is

\* From the Departments of Urology, New York Post Graduate Medical School and Hospital, Columbia University and Gouverneur Hospital.

seen in individuals with otherwise normal urethras or may be associated with congenital abnormalities such as hypospadias,

demonstrate a relatively increased number of these lesions. Treatment consists of endoscopic destruction of the bands either

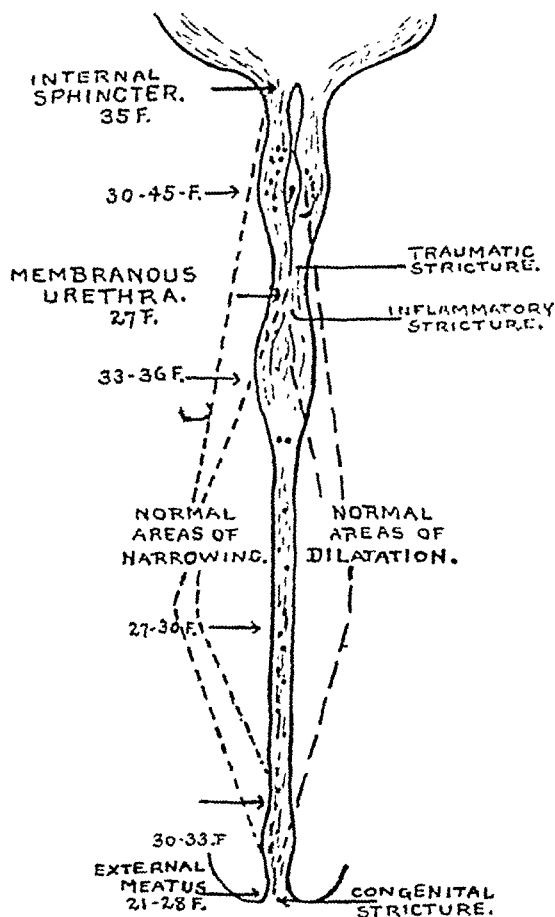


FIG. 1. Schematic drawing of the urethra showing normal points of narrowing and most frequent sites of constriction.



FIG. 2. Spasmotic stricture at bulbomembranous junction; urethrocytogram shows no evidence of abnormality.

etc. The extent and depth of the meatal stricture is determined by passing a blunt pointed probe, with its tip on the urethral floor, beyond the constricted zone, noting any irregularities with the tip of the instrument as it is withdrawn in a vertical position. Dilatation is of no avail; meatotomy by simple incision or by the method of Ballenger and Elder gives permanent relief.

Congenital stricture of the urethra is infrequent. It occurs as a fold of mucous membrane between the meatus and bulbous portion (Fig. 3), or as a valvular or band-like type in the prostatic urethra. The diagnosis is best made with the cystourethroscope. The more routine use of cystourethroscopy in recent years, has served to

with the Bugbee or the author's type of electrode.

Obstruction due to the injudicious use of some type of corroding chemical or antiseptic is comparatively rare. The entire canal is never involved, normal areas of mucosa alternate with those of scar tissue. No instrumentation is attempted during the active stage; sedative and demulcent injections are administered until the reaction subsides. The extent of the injury may then be determined by instrumental and urethrocytographic examination. The further treatment is essentially the same as for injuries of the urethra.

Traumatic strictures are caused by an internal or external injury to the urethra. Constriction usually begins as soon as healing takes place with the early formation, at times, of dense cicatricial tissue. Complete occlusion is rare and only develops when there is an opening in the urethra proximal to the obstruction. Such occlusion is usually single as opposed to the

multiple type of inflammatory origin, and is most frequent in the membranous and bulbous portions of the urethra (Fig. 4). They may follow unskillful instrumentation with sounds, cystoscopes, etc., (Fig. 5) particularly when an anesthetic is used; or may develop after punch operations or transurethral resections where the caliber of the instrument is disproportionate to the size of the canal. In some of those patients with persistent urinary disturbance following instrumentation or transurethral resection for enlarged prostate, we have found bands of fibrous tissue extending between the lateral lobes or bridging the internal sphincter which either interfere with the egress of urine or serve to prolong the urinary disturbance unless promptly destroyed. A calculus may become pocketed behind the area of constriction and increase to such an enormous size as to cause complete obstruction. Two cases were seen and operated on my service at Gouverneur Hospital during the past year. External violence to the urethra from falling astride objects, bullet wounds or injuries to the pelvis may result in lacerations or complete rupture of the canal with the formation of subsequent scar tissue (Figs. 6 and 7).

Every traumatized urethra should be examined carefully, for any injury, slight or severe, may eventuate in a stricture without giving preliminary manifestation of urinary disturbance or obstruction. The site and extent of the constriction in relationship to the lumen of the canal is determined by instrumental and urethrocytographic examinations. Early diagnosis is essential and prolonged dilatation should be carried out to forestall, if possible, the formation of cicatricial tissue. If dilatation is unsuccessful, as it so frequently is in traumatic strictures, incision by internal or external urethrotomy or resection by the Cabot or McGowan methods should be performed.

Of the acquired types, inflammatory strictures are most common and usually due to gonorrhea. They may be large or small, and may or may not be permeable

to whips or even filiforms. That these constrictions are not caused by the inflammatory process per se is shown that with

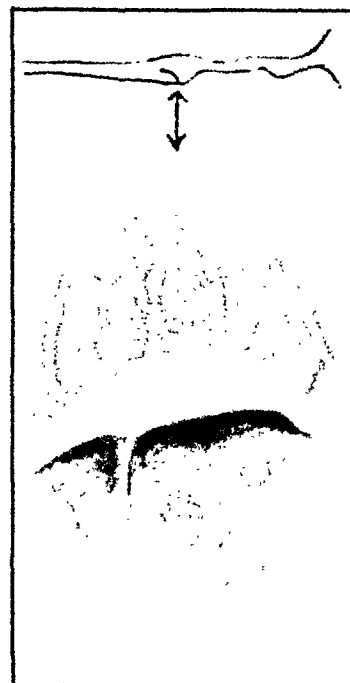


FIG. 3. Sketch of cystoscopic view of congenital stricture; a valvular fold in bulbous urethra.

the proper treatment of acute urethritis, there is a decreased tendency to the development of dense scar tissue; and is confirmed by the fact that in recent years, with earlier and milder remedial measures, there has been a distinct decrease in their number. They develop slowly, rarely before the first year following the initial infection, and may appear ten to twenty-five years later. The bulbous and particularly the bulbomembranous areas are far more prone to constriction than the pendulous portion, although any part of the canal may be affected (Figs. 8 and 9). Contraction takes place more slowly and to a lesser degree in the pendulous urethra than in the bulbomembranous region. Bar-like elevations or contractures of the vesical neck may occur as terminal cicatricial changes of hyperplasia of the glandular structures at the vesical lip, and clinically, may simulate hypertrophy of the prostate.

A large or small caliber stricture may exist for a considerable length of time

without causing characteristic symptoms. The diagnosis is based on what has been termed by Guyon as "urethral history" of

With strictures of small caliber, residual urine is almost constant and in absence of treatment, irremedial damage to the blad-



FIG. 4. Traumatic stricture; atresia of pendulous urethra.

the case. The history may reveal a previous chancre or chancroid, injury or attacks of acute or chronic urethritis. On inspection and palpation, there may be evidence of tuberculosis or neoplasm. A stricture of the anterior urethra, if nodular, can be palpated. The first manifestation may be a gleet discharge of long standing, free of gonococci. Increased frequency of urination may be unnoticed for a long time by the patient before it gives rise to discomfort. Later, with infection of the urethra and bladder, the urinary disturbance becomes more marked and may overshadow the obstruction. The urine may be clear except for shreds, or cloudy due to varying amounts of pus, mucus, etc. The latter is dependent on the chronicity, the degree and amount of infection of the urethra, prostate and glandular adnexa which invariably are involved in the course of the disease, and in more severe cases, the bladder or upper urinary tract (Fig. 10). Increasing difficulty of urination, decreasing size of the stream or loss of projectile force or dribbling may be noted.

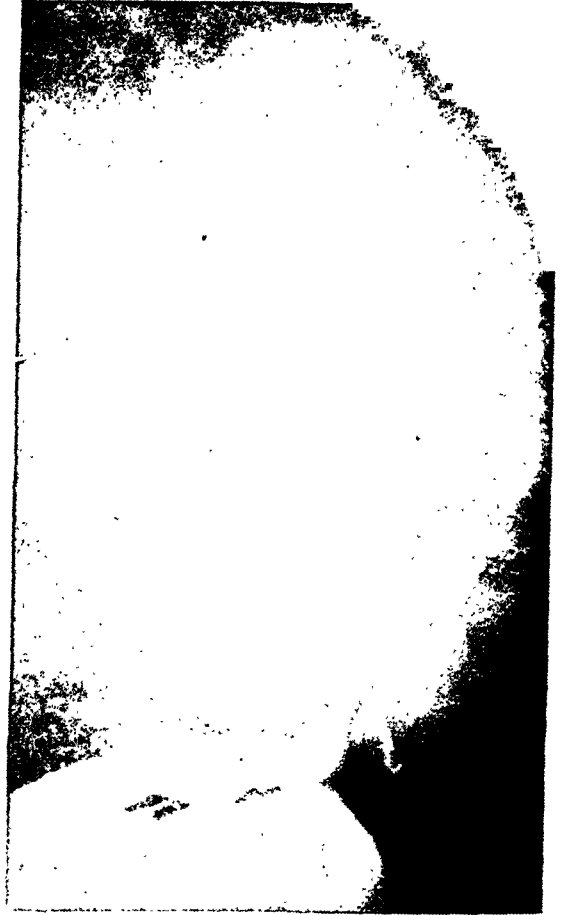


FIG. 5. False passage in posterior urethra following instrumentation.

der and upper urinary tract may occur. Hypertrophy of the bladder wall may be followed by atony and false incontinence, really a type of retention with overflow. At any stage of this process, infection may extend to the upper urinary tract with grave secondary renal lesions. Retention may be sudden, partial or total and is due to the edema or congestion in the partly occluded canal. The symptoms are not indicative of the size of the stricture, any group may be present.

The same careful routine examination is carried out as with any other disorder of the lower urinary tract, consisting of: microscopic examination of the urethral discharge, if present; multiple glass test of voided urine, with macroscopic, chemical

and microscopic examination of the specimen; inspection and palpation of the urethra and external genitalia; bimanual rectal

and followers, both catheters and bougies, whalebone filiforms, olive tipped bougies and conical tipped sounds. A sound which

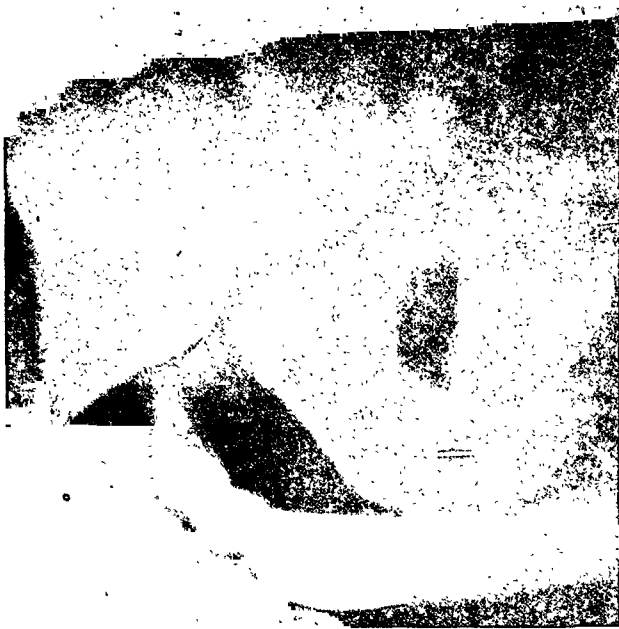


FIG. 6. Traumatic stricture, large caliber, at bulbous urethra (straddle injury).

palpation of the prostate and seminal vesicles; microscopic and cultural examination of the prostatovesicular secretion; direct instrumental and endoscopic examination of the urethra; and urethrocytography.

Direct instrumental examination serves to locate and calibrate the stricture and demonstrate the number of coarctations. The primary requisites are meticulous asepsis and gentleness in technique. Clean hands and sterile instruments with plenty of sterile water-soluble lubricant are essential. The genitalia are prepared as for minor surgery, the anterior urethra lavaged with a mild antiseptic solution. If the utmost care is exercised and the cooperation of the patient obtained, local anesthetics, as a rule, are unnecessary. However, for the neurotic, apprehensive patient with a hypersensitive canal, the injection of a surface anesthetic such as urethrol or diothane, in a water-soluble lubricant, retained for ten minutes with a penis clip, will aid materially in relieving any complicating spasm and facilitate the examination. The instruments required are the bougie a boule, Phillips woven silk whips

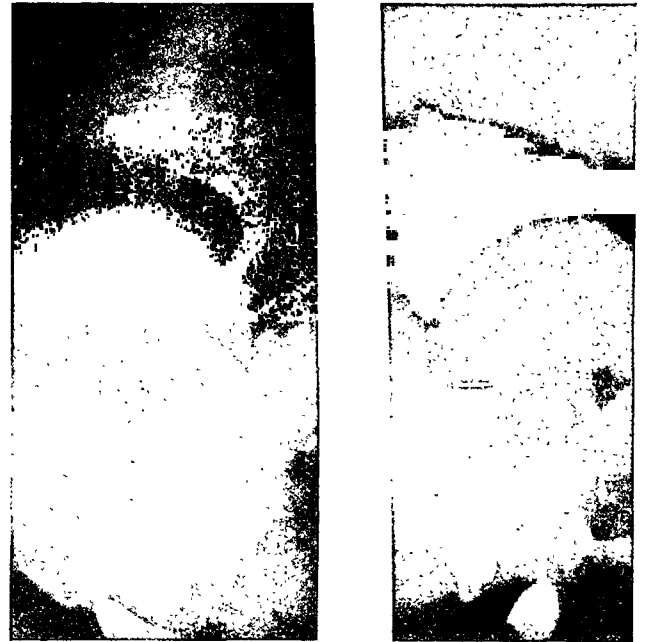


FIG. 7. Traumatic stricture, filiform, at bulbomembranous junction (complete rupture of urethra).

I have employed for many years has certain advantages over those in routine use. The curve is similar to that of the Van Buren. The distal 3 inches of the shaft are tooled down to a caliber several sizes smaller than the proximal portion. Its caliber is gradually increased in a half inch to the widest diameter from which point it tapers by degrees to a conical tip. It is easy of introduction and due to its narrowed shaft, the meatus and pendulous urethra are not kept on the stretch while the area of constriction is being dilated.

To determine an abnormal narrowing, a well lubricated sound of size 24 or 26 French is gently introduced into the urethra, almost of its own weight, its tip following the roof of the canal until its progress is arrested by an obstruction. If the meatus is too small for the passage of instruments, meatotomy should be performed. If the sound fails to "engage," smaller instruments are passed in succession until the lumen of the stricture is "fitted." The distance from the meatus to the area of constriction is then measured

on the shaft of the instrument. Sounds may be used above 21 or 22 French; a bougie a boule or olive tip bougie to size 10 or less;

gentle curve or double angulation, or make repeated attempts. For this purpose, one filiform carefully manipulated, is as a rule,



FIG. 8. Inflammatory stricture, small caliber at bulbomembranous junction, with chronic infection and dilatation of urethral glands.

and for a filiform stricture, the Phillips whip with either catheter or bougie follower. It is well to remember at this point that sometimes a large sized instrument can be passed where a smaller is unsuccessful. However, if a large instrument fails to enter the opening, and is forced, it may so distort the stricture face as to make the insertion of a filiform more difficult.

For strictures of small caliber, the Phillips whip is far superior to the whale bone filiform; it will slip over slight obstructions, will not catch in every small opening or pocket, causes less trauma and its introduction is usually more successful. Unlimited patience and the utmost gentleness are essential for their treatment. A distorted crooked canal may give rise to considerable difficulty. If the whip fails to pass the obstruction, it is gently manipulated by advancing, withdrawing and rotating, and may in most instances, be "eased" through the opening. It may be necessary to bend its tip at an angle,



FIG. 9. Inflammatory stricture, small caliber, at bulbomembranous junction, with chronic infection and dilatation of Cowper's glands and prostatic ducts.

preferable to the use of several. It may pocket itself in a recess or become knotted, but the proof of a successful introduction is the ease with which it enters the bladder with its attached follower.

The cystourethroscope has distinct advantages in demonstrating the surface appearance of the mucosa and changes in the urethral wall. In the hyperemic stage the mucosa is engorged and succulent, has an inflamed appearance, bleeds easily and bulges into the visual field with the urethral opening as a central point with radiating lines; whereas in the anemic state, the mucosa is grayish-white and the urethral wall funnels from the end of the instrument to a central point. The zone of coarctation interferes with further introduction of

the instrument. The endoscope is of questionable value as a means of passing a filiform through the openings of multiple strictures, but may be indispensable for traversing a single stricture.

X-ray diagnosis by urethrocytograms delineates the character, site, size and number of strictures and demonstrates the presence of complicating factors in the urethra and bladder. If carried out with proper technique, it is a far safer diagnostic procedure than repeated instrumentation. It is particularly applicable to patients with small caliber strictures in whom instrumentation is difficult or impossible; who have chronic dilatation of the adnexal glandular structures such as of the glands of Littre, Cowper and of the prostate, or pockets and fistulous tracts. If however, instrumentation has been attempted, an interval of least forty-eight hours should elapse before the urethrocytogram is made.

The various methods of treatment are preventative, instrumental and surgical. The prevention of venereal disease, education of the layman as to the dangers and sequels of inadequate treatment, and a better understanding of the problems involved by the practitioner, are as necessary today as in former years. The present venereal program of our municipal, state and federal governments should be a distinct aid in eliminating one of the most prolific causes of stricture, i.e., gonorrhea.

Many strictures are amenable to office treatment, for the majority respond to gradual dilatation. Rapid dilatation by divulsion is mentioned only to be condemned; the lacerations caused by the too speedy forcible stretching with sounds, dilators, or tunneled sounds threaded over filiforms, result in an increased deposition of dense scar tissue. Each patient presents an individual problem, and consideration must be given to temperament, mental and social status as well as his physical condition.

In those patients presenting evidence of acute retention or partial obstruction, or if

the stricture is of such size that a follower cannot be introduced, the filiform may be tied in place with the assurance that the



FIG. 10. Inflammatory stricture, filiform, at bulbomembranous junction, with false passage following instrumentation, chronic prostatitis, prostatic calculi and small diverticulum of bladder.

urine will dribble alongside it, thus relieving the retention. At the end of twenty-four or forty-eight hours, the area of cicatrization will have softened sufficiently to permit several followers or bougies of successively larger sizes to be passed without difficulty. The bladder is lavaged and an instillation of a weak solution of silver nitrate 1:5000, or one of the organic silver compounds is made to the prostatic urethra before the follower is withdrawn. The re-insertion of an indwelling filiform is seldom necessary; the patient usually voids spontaneously. Further dilatation may be accomplished by gradually increasing the size of the followers, or passing olive tipped bougies, never more than two to three sizes at a time at intervals of three or more days. It



may be advisable to start with a size smaller than was used at a previous treatment. As the lumen of the canal dilates, the periods between instrumentation are correspondingly lengthened so that when sizes 20 or 21 French are reached, the intervals may be three weeks apart.

For the progressive dilatation, conical tipped steel sounds are employed at intervals of two or three weeks or longer. If the patient's condition warrants, these periods may be lengthened to intervals of two or three months or even six months. He should be warned that re-contraction will take place, and to insure against recurrence, dilatation must be continued over a long period of time. The lumen of each canal varies, and consideration must be given to the size to which a stricture can be dilated.

The only manifestation of a large caliber stricture (24 to 26 French) may be a prolonged gleet discharge. These patients are materially benefited by dilating the lumen of the canal to a considerably larger size, 30 to 32 French or even more.

Preliminary to and during the course of treatment of a constriction, the urinary tract must be rendered as aseptic as possible by urinary antiseptics and acidulation of urine, increased ingestion of fluids and a non-stimulating diet. Although dilatation promotes drainage and aids in the elimination of infection, supplemental treatment must be directed to the co-existing and complicating factors, to obtain more speedy and satisfactory results. In the presence of specific organisms, vaccines and bacteriophage are of distinct value.

The various types of surgical intervention by incision or excision are not office procedures. One or more of these methods are indicated in those relatively few patients in whom instrumentation is unsuccessful or is followed by bleeding or marked local or systemic reaction; or when the stricture is cartilaginous or resilient and gradual dilatation has failed. Internal or external urethrotomy or excision are indicated where marked infection and complicating factors such as urethral or vesical

calculus, fistula, pockets, false passage or suppurative processes co-exist; or in those individuals who are unable or unwilling to cooperate in obtaining treatment.

With proper care and cooperation, the prognosis of stricture of the urethra is good. Its successful termination is dependent not only on thorough and regular treatment but on prevention, the eradication of infection and the anticipation and early recognition of such complications as will necessitate operative intervention.

#### SUMMARY

For the diagnosis and treatment of the varied types of stricture, urethro-cystography, the roentgenographic delineation of the urethra and bladder with the use of an innocuous contrast medium is invaluable. It may be used alone, or to supplement other methods of diagnosis. Associated pathologic lesions of the urethra and glandular adnexa are graphically delineated by this method. The treatment of stricture is based on a knowledge of the etiological factors and the degree and extent of pathology present. Most strictures respond to gradual dilatation and other office procedures. The prevention of venereal disease and a better understanding of the need for early and adequate treatment will aid in the further reduction in the occurrence and severity of strictures.

#### REFERENCES

- BÉCLÈRE, H. and HENRY, R. Radiography of urethral strictures. *Jour. d'Urol.*, 13: 417-424, 1922.
- BURDEN, V. G. Roentgenology of the male urethra. *Surg. Gynec. and Obst.*, 38: 3, 1924.
- CUNNINGHAM, J. H., JR. The diagnosis of stricture of the urethra by roentgen ray. *Tr. Am. Assn. Gen.-Urin. Surg.*, 5: 369-371, 1910.
- FUNKHAUSER, S. P. Urethrography in the male. *Urol. and Cutan. Rev.*, 36: 644-650, 1932.
- HYAMS, JOSEPH A., KENYON, H. R., KRAMER, S. E., Urethrocystography in the male; *J. A. M. A.*, 101: 2030-2035, 1933.
- KOHNSTAM, G. L. S. and CAVE, E. H. P. The radiological examination of the male urethra. *Brit. Jour. Radiol.*, 30: 121-127, 1925.
- NICHOLSON, M. A. and FIALA, M. J. Roentgenography of the urethra. *Jour. Urol.*, 28: 461-476, 1932.
- SICARD and FORESTIER. Radiologic exploration of urethra with lipiodol. *Bull. Soc. mèd. d'Hôp. de Par.*, 40. 7, 1924.

# REMOVAL OF FOREIGN BODIES FROM URETHRA AND BLADDER

HOWARD S. JECK, M.D., F.A.C.S.

Assistant Professor of Clinical Surgery, Department of Urology, Cornell University Medical College

NEW YORK

**S**TONES of the bladder and stones lodged in the urethra are not foreign bodies in the precise sense as are those objects introduced into the urethra and bladder from without. As to their removal, however, both types of foreign bodies present much the same problem. From a practical standpoint, therefore, both urethral and bladder stones should be considered as foreign bodies.

It is not the purpose here to recount the varieties of urethral and bladder foreign bodies nor their modes of introduction. Briefly, however, it may be stated that almost every conceivable type of object, which is small enough to pass through the urethra, from nails to snails has been found in the human urethra or bladder. While a few foreign bodies have found their way to the bladder through violence (bullets) and some have migrated from other parts of the body (fracture pin) the great majority of objects in this category have been placed in the urethra for purposes of sexual gratification by the patients themselves or in the case of women attempting to induce abortions on themselves, the urethra being mistaken for the cervical canal.

The methods employed for the removal of urethral foreign bodies are (1) meatotomy, (2) urethroscopy, (3) internal urethrotomy, (4) dilatation of the urethra, and (5) external urethrotomy.

The employment of any one of the foregoing procedures may suffice to remove a foreign body from the urethra, particularly if the foreign body is a stone. Usually, however, a combination of two or more of the procedures is necessary and as a general rule the nearer the foreign

body is to the urethral meatus, the more likely is the attempt to succeed.

*Meatotomy.* In the case of an abnormally small meatus, it is readily understood why a small stone, for example, which has travelled all the way from the kidney pelvis through the bladder and through most of the urethra without unusual incident, may become impacted at the fossa navicularis or possibly just within the meatus. Here meatotomy usually performed under local anesthesia (two or three drops of 1 per cent novocain are injected with a hypodermic needle into the glans in the midline on the ventral surface as close to the meatus as possible) will promptly release the stone.

*Urethroscopy.* Blind groping for foreign bodies with foreign body forceps, especially those of the alligator type, may be tried, but is rarely successful. It is rather difficult to grasp the foreign body without grasping the urethral mucosa as well. The latter danger may be obviated by the use of the urethroscope, preferably one of the endoscopic type. With the jaws of the forceps protruding beyond the endoscopic tube, an attempt is thus made to grasp the foreign body cleanly. If successful, traction is made on the forceps and on the endoscope at the same time, thereby removing the two instruments as a whole. In objects whose shortest diameter approximates that of the inside diameter of the endoscope, it is next to impossible to withdraw them through the tube.

*Internal Urethrotomy and Dilatation of the Urethra.* Since a urethral stricture may serve as a barrier to the passage of a foreign body, an internal urethrotomy may be indicated. If the stricture is of a

calibre sufficiently large to admit an Otis urethrotome, this should be the instrument of choice. In the event that the stricture

the stricture may be filiform in size and should be attempted before resort is had to other more involved methods.

In 1930, the author reported the removal of a thin triangular piece of bone which had become engaged in the posterior part of the anterior urethra. A stricture about midway of the penile portion of the urethra rendered the manipulation of urethral instruments difficult. A filiform was finally passed, over which a 14 F. tunnelled sound was guided to the bladder. This afforded sufficient dilatation to permit the fragment of bone to be grasped with alligator forceps. While traction was made on the forceps, an assistant "milked" the urethra over the piece of bone, thereby materially assisting in propelling it forward.

Stones and other foreign bodies in the posterior urethra which cannot be brought out through the external meatus may sometimes be pushed into the bladder by means of a sound. They are then treated as foreign bodies of the bladder.

**External Urethrotomy.** The indications for this procedure are (1) failure to remove the foreign body by other methods, (2) the presence of a complicating tight stricture of the deep urethra, and (3) the presence of a complicating periurethral abscess or phlegmon.

A word of warning as to what portion of the urethra should be cut from without is here in order. Whenever at all possible, the incision into the urethra should be made posterior to the pendulous portion, although the foreign body may lie anterior to this point. In other words, the usual perineal external urethrotomy should be performed. If the incision is not directly over the foreign body, it may be necessary with the aid of forceps to pull the foreign body backwards or forwards in order to extract it through the urethral wound.

For foreign bodies anterior to the external urethrotomy wound, success is sometimes had by pushing the object backwards with a sound in the anterior urethra while traction with forceps is made from behind.

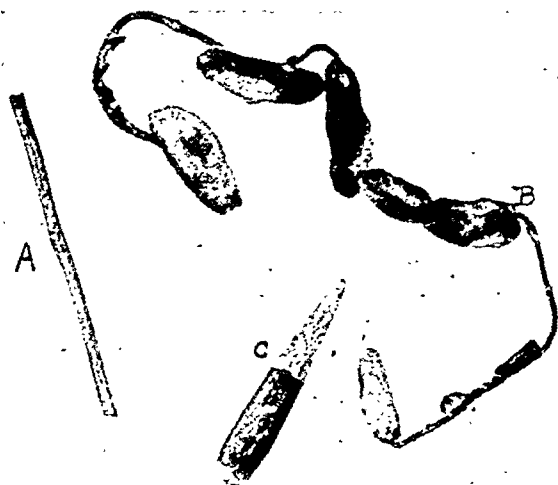


FIG. 1. Foreign bodies removed on the Bellevue Urological Service since September, 1936: A, a piece of wood about 7.5 cm. long and 0.4 cm. wide, found in bulbous urethra, complicated by periurethral phlegmon; removed by external urethrotomy. A few weeks later another piece of wood, twice as long, coated with incrustations and evidently the original of which A was a part, was found by cystoscopy, lying transversely in the bladder; latter was removed by cystoscopic means. B, filiform whip, nucleus for a string of stones, found coiled in the prostatic urethra which was greatly dilated; removed by suprapubic cystotomy. C, artist's easel peg, about 5.5 cm. long and 1 cm. in its widest diameter, found in deep urethra and removed by external urethrotomy.

All three patients made uneventful recoveries.

approximates filiform dimensions, the Maisonneuve instrument should first be tried, but this can probably be employed only when one is successful in passing the whip which acts as a guide, not only through the stricture, but past the foreign body as well.

After using the Maisonneuve urethrotome, if the narrowed portion of the urethra is still not large enough to permit the foreign body to pass, then further enlargement may be accomplished by means of the Otis instrument.

If the urethra posterior to the stricture is large enough to permit fairly free movement of the stone, it is quite possible to dilate the stricture by means of sounds. This can occasionally be done although

*Only as a last resort should an incision be made directly over a foreign body which is situated in the penile urethra* for a fistula is almost certain to follow. Such a fistula rarely if ever closes spontaneously and is exceedingly difficult to repair by operative measures.

But when all other methods to remove a foreign body from the penile urethra have failed and it becomes absolutely necessary to incise the urethra directly over the foreign body, the urinary stream should be diverted in order to promote healing and to avoid a urinary fistula. If in the attempt to remove the same foreign body an external urethrotomy of the deep urethra has preceded the more anterior urethrotomy, the drainage can be very handily established by placing a perineal tube into the bladder through the deep urethrotomy wound; otherwise drainage should be established by either a posterior external urethrotomy or by means of a suprapubic cystotomy.

*Foreign Bodies in the Bladder.* As in the case of the urethra, the simpler non-operative methods of removing foreign bodies from the bladder should be tried first unless the patient's condition is such that temporizing may place his life in jeopardy. The method of choice depends largely on the type and size of the object to be removed. Usually the foreign body is removed by employing one of the five following procedures: (1) cystoscopy, (2) injection of solvents, (3) litholapaxy, (4) suprapubic cystotomy, or (5) external urethrotomy.

*Cystoscopy.* Objects small enough to pass through the urethra can frequently be removed in toto by means of the operating cystoscope and foreign body forceps. As suggested in the endoscopic removal of urethral foreign bodies, it is not infrequently best, after grasping the object to allow the forceps to protrude beyond the end of the scope and remove the scope, forceps and foreign body as a whole rather than attempt to pull the object through the cystoscopic sheath.

Small stones whose smallest diameter is larger than the cystoscopic sheath may be broken into two or more fragments and the fragments removed individually with a foreign body instrument or aspirated through a cystoscopic sheath or a Bigelow evacuating tube. Satisfactory instruments for the purpose are the cystoscopic rongeurs of either Young, Lowsley or Ravich. The McCarthy evacuating bulb is an excellent aspirator.

*Injection of Solvents.* Quite a number of instances are recorded wherein portions of paraffin and wax in the bladder have been dissolved by various solvents. Notable among these are the following case reports:

1. After experimenting with xylene, kerosene, paraffin oil and gasoline as well as varying proportions of these solvents, Caples removed a piece of paraffin from the bladder by several injections of 33 $\frac{1}{3}$  per cent gasoline in paraffin oil; 125 c.c. of the mixture were given at each injection at a temperature of 110 degrees F. and the solution was retained from two to five hours. The paraffin was exposed to the solvent for a total of seventeen hours during a three day period. The paraffin was recovered from the expelled bladder contents by chilling the solution whence precipitation of the paraffin took place. A week after the process was completed, the patient was cystoscoped and no foreign body was seen.

2. Turner has reported the removal of a piece of paraffin about the size of a 4 inch segment of lead pencil by employing xylol as a solvent. He introduced a No. 20 F. catheter, filled the bladder with sterile water and then injected 12 c.c. of xylol. After keeping the patient in the recumbent posture for thirty minutes, during which time the bladder region was massaged at frequent intervals, the fluid was withdrawn. The last portion of the fluid was of a milky appearance. A little later, cystoscopic examination showed no foreign body. Five days later, the report from the patient's physician stated that the patient was entirely normal.

## Jeck—Foreign Bodies in Bladder

3. Katzen, influenced by the success of Harris in the employment of liquid petrolatum as a solvent for paraffin was successful in removing three portions of a paraffin candle which were attached to one another by the wick. Previous attempts had been made to grasp the candle with cystoscopic forceps, but without much success. Katzen injected 100 c.c. of warm, sterile, liquid petrolatum through a rubber catheter and then thoroughly massaged the suprapubic region. The patient was instructed to hold the solution as long as possible and to massage the bladder region at intervals. The following day, the bladder was irrigated with a 1:5000 mercuric oxycyanide solution and another injection of 100 c.c. warm, sterile, petrolatum was again made. Suprapubic massage was instituted as before. On each occasion the patient was able to retain the oil for two to three hours without any evidence of bladder irritation.

Two days later, the patient was re-examined by cystoscopy and neither the wax nor the wick was visible, the latter apparently having been passed without the patient's knowledge.

**Litholapaxy.** While the lithotrite, as the name implies, is an instrument designed for crushing stones, it is sometimes used for breaking up other foreign bodies in the bladder which lend themselves to this mode of attack. It is difficult to make any rule governing the size of a stone which may be appropriate for litholapaxy. An important factor concerning this point is the hardness of the stone. But generally speaking any stone whose shortest diameter is no greater than 3 cm. may be crushed.

Unless contraindicated by certain forms of bladder neck obstruction, diverticula, the size of the stone, or for some other equally specific reason, litholapaxy should be the method of choice for the removal of bladder calculi. When performed by one skilled in the method, the mortality is less and the period of hospitalization far shorter than if the stone were removed by means of an open operation.

In any type of prostatism complicating stone in the bladder, due consideration must be given the bladder neck obstruction. If the stone is removed and the obstruction is ignored, other stones are almost certain to follow.

In the lesser types of obstruction (e.g., median bars and the sclerotic prostate), the bladder stone may be crushed and at another sitting the obstruction may be resected transurethraly. In the generally enlarged adenomas of the prostate or in patients with poor kidney function, the two stage suprapubic prostatectomy is usually the procedure of choice, the stone being removed at the time of the suprapubic cystotomy (the first stage of the operation).

**Suprapubic Cystotomy.** This procedure is reserved for those foreign bodies which cannot be removed by the non-operative and cystoscopic methods and also for those cases complicated by the types of prostatism which are not especially amenable to transurethral resection. In addition to stone, the kind of foreign body requiring suprapubic cystotomy for its removal may be most any object which is small enough to enter the bladder via the urethral route and also the comparatively rare objects which have either entered the bladder through gunshot wounds (bullets) or have migrated there from other portions of the body. Belonging to the latter class are a steel pin (inserted into the neck of the femur in the treatment of fracture), paraffinoma (following injection for hernia and a bullet which had lodged originally in the upper portion of the thigh). Among common objects which were inserted into the urethra and removed from the bladder by means of suprapubic cystotomy, the following noteworthy examples were encountered on the Bellevue Urological Service during the past twenty years: rubber catheters and pieces of rubber tubing, portions of lead pencils and other smooth pieces of wood, portions of glass thermometers, a glass vial and other smooth pieces of glass, portion of metallic sound, pipe stem, hair pin and hat pin.

Nearly all such objects may serve as nuclei for stone formation and for this reason, many suprapubic cystotomies which are required for the removal of incrustrated foreign bodies could be avoided if the patient would seek medical aid as soon as he realized his own inability to recover the foreign body. Thus a clean hair pin in the bladder is ordinarily very easily recovered by means of an operating cystoscope and foreign body forceps, but a hair pin buried within a stone is a very different proposition.

*Stones within Diverticula.* The removal of stones within diverticula usually necessitates suprapubic cystotomy. Even then with the bladder wide open, it is not always easy to remove such stones. If the stone or stones can not readily be evacuated, the diverticular opening should be enlarged. If the diverticulum is situated on the posterior wall of the bladder and can be reached by an assistant's fingers introduced into the patient's rectum, considerable help may be given the operator by the assistant's efforts to push the stone out of its pocket. In certain instances, especially in aged individuals where the diverticulum and stone are both very large and not easy of access, and provided the stone is not the cause of any great amount of discomfort to the patient, it may be wiser to allow the stone to remain than to subject the patient to a major procedure, the shock or possible complications of which might cause his death.

*External Urethrotomy.* If the foreign body is not too large to pass through the posterior urethra, external urethrotomy may be preferable to suprapubic cystotomy in certain instances. Other things being equal, this would apply to patients with tight strictures of the deep urethra and individuals with very large pendulous abdomens.

#### REMOVAL OF FOREIGN BODIES BY MEANS OF SPECIAL TECHNIQUE

A few foreign bodies both in the urethra and in the bladder have been removed by

means of methods which do not fall under any of the above classifications:

1. *A bat pin, the head of which evidently lay in the posterior urethra or the bladder.* Several inches of the shaft of the pin protruded through the dependant portion of the penis. The pin was removed by the following non-operative maneuver: By firmly grasping the shaft of the pin near its end, the head was pulled forward into the urethra as far as possible. The shaft was then inclined backwards reversing the original positions of the head and the point, while steady forward pressure against the head through the shaft was maintained until it finally passed through the external meatus.

2. The following most unusual method of foreign body removal was reported by Schulte:

A boy who had inserted a paraffin pencil into his urethra and lost control of it came for medical aid. On cystoscopic examination, a small mass of paraffin was seen at the edge of the air bubble. By means of a cystoscopic rongeur, several pieces of paraffin were chipped off, but the patient began to have pain and the procedure was stopped. Noting that the paraffin floated on the top of the irrigating medium, Schulte suggested that the patient try urinating when standing on his head. Two weeks later, the patient returned for re-examination. He said he had forced fluids and when his bladder became distended, he hung head down from a trapeze and urinated, whereupon the piece of paraffin was expelled. Another cystoscopic examination at this time revealed a normal bladder.

3. The difference in specific gravity between the irrigating medium and piece of wax makes it possible to remove the latter by cystoscopy:

O'Neil in attempting to remove a piece of wax crayon by means of cystoscopy, noted that the foreign body floated in the boric acid medium in such a way that it could not be grasped. He emptied the bladder and then filled it with olive oil

whereupon the wax sank to the floor where it could be readily grasped with cystoscopic forceps. O'Neil states that the procedure was less painful than ordinary cystoscopic examinations where water is employed, but believes that mineral oil would be better than olive oil for the reason that it does not turn rancid.

4. *Cystoscopic Removal of a Snail.* Though quite unique among foreign bodies of the bladder, snails according to Mauterer present no especial difficulty in their removal. In the case of an epileptic girl who had obviously put two snails into her own bladder, one was passed spontaneously and alive while the other, dead, was removed by cystoscopic means.

#### KIDNEY FUNCTIONAL TESTS

Before any extensive attempt is made (operative or otherwise) to remove a foreign body from the urethra or bladder, adequate kidney functional tests should be performed. It is not difficult to overlook the fact that the patient's kidneys may suffer as a result of back pressure due to an impacted urethral foreign body or a foreign body in the bladder which greatly interferes with the act of urination. This point is well illustrated by the following brief outline of the treatment instituted in the case of a twenty-one year old male who was admitted to the Urological Service of one of the large New York City hospitals a number of years ago, before the days of blood chemistry and intravenous urography. It was not the custom then as it is today to perform routine renal functional tests on all urological patients, especially those who pathological conditions were seemingly amenable to minor surgery.

An x-ray picture showed the shadow of a stone about the size of an ordinary olive, located apparently in the prostatic urethra. By rectal-digital palpation, a hard object could be felt in the midline of the prostate gland. The patient appeared to be in good general physical condition and a suprapubic cystotomy was performed. The diagnosis was confirmed. A stone was found

in the prostatic urethra and was readily removed. A suprapubic drain was inserted into the bladder and the patient was sent to his bed in good condition. Three days later the patient died of uremia. Had it been recognized before operation that the boy's kidneys were probably badly damaged as a result of prolonged urinary obstruction, the proper procedure would have been a suprapubic cystotomy with drainage, constituting one operation and then later, after the kidney function had improved, removal of the stone through the cystotomy wound.

A patient, therefore, with a foreign body in the urethra or in the bladder, which has caused considerable kidney damage should be treated in much the same way that a prostatic patient is treated where the two-stage method of prostatectomy is contemplated. The first operation should be a suprapubic drainage in order to permit the kidney function to improve. The second operation should be removal of the foreign body, either suprapubically or by means of an external urethrotomy or perhaps by some other measure which might necessitate considerable urethral manipulation.

#### SUMMARY

1. Because of similarity of technique employed in their removal, urethral and bladder stones are included along with the other types of foreign bodies.

2. Methods usually employed for the removal of urethral foreign bodies are meatotomy, urethroscopy, internal urethrotomy, dilation of urethra, external urethrotomy. Concerning external urethrotomy, the impropriety of opening the pendulous urethra directly over a foreign body is stressed.

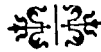
3. Methods usually employed for the removal of foreign bodies in the bladder are cystoscopy, injection of solvents, litholapaxy, suprapubic cystotomy, external urethrotomy.

4. Attention is called to several cases of foreign bodies whose removal was accomplished by means of special techniques.

5. The importance of a knowledge of renal function before resorting to operative procedures is stressed.

## REFERENCES

- RAVENSWAAY. Steel pin inserted into neck of femur found in bladder. *Am. Jour. Surg.*, 31: 566, 1936.
- JECK. Foreign bodies in the urethra. *Am. Jour. Surg.*, 9: 335, 1930.
- CAPLES. Foreign bodies in the urinary bladder. *Surg. Gynec. and Obst.*, 29: 315, 1919.
- TURNER. A foreign body of paraffin in the urinary bladder removed with xylol as solvent. *Jour. Urol.*, 33: 471, 1935.
- KATZEN. Paraffin foreign body in the bladder. *J. A. M. A.*, 105: 1422, 1935.
- HARRIS. A case of paraffin foreign body in the bladder. *Med. Jour. and Rec.*, 134: 372-374, 1931.
- WHITTAKER. Paraffinoma following injection for hernia with ulceration into bladder. *Proc. Staff Meet. Mayo Clinic*, 11: 22-25, 1936.
- PICATOSTE AND SILIO. Emigration to urethra and bladder of bullet tolerated 12 years in upper left thigh. *An. Casa de Salud Valdecilla*, 6: 311-315, 1935.
- SCHULTE. A novel way of ridding the bladder of paraffin. *Jour. Urol.*, 34: 313, 1935.
- O'NEIL. Personal communication; also see *Trans. New England Branch A.U.A.*, 1930-1931, p. 24.
- MAUTERER. Foreign body in urinary bladder. *Am. Jour. Surg.*, 32: 178, 1936.





# HYDROCELE AND VARICOCELE: OPERATIVE AND INJECTION TREATMENT

LLOYD B. GREENE, M.D.

Urologist, Burlington County Hospital; Associate Urologist, Pennsylvania and Bryn Mawr Hospitals

PHILADELPHIA

THE tunica vaginalis testis is derived entirely from the peritoneum through the descent of the testicle. The visceral layer invests the testicle and epididymis completely, except at their point of attachment, to each other and posteriorly where the vessels and nerves enter the organs. This layer is continuous with the parietal layer, which, when the funicular process is obliterated forms a closed sac with its proximal limit just proximal to the head of the epididymis. The coverings of the testicles are independent and completely separate.

The term hydrocele implies a collection of serous fluid within the cavity of the tunica vaginalis testis greater than the small quantity necessary to moisten its surface and considered to be normal. Any irritation affecting the tunic, primarily, or secondarily, from testicle or epididymis, gives rise to an effusion into its cavity; absorption is limited and results in a hydrocele.

A failure of the funicular process to become completely obliterated allows a variety of abnormalities depending on the anatomical variation present. Some writers designate as hydrocele, collections of fluid in the canal of Nuck, in the female.

The following classification, according to location, (Jacobson) is convenient and is standard in the recent literature.

## 1. Hydrocele of the testis.

### A. Hydrocele of the tunica vaginalis.

- (1) Ordinary type, distending the tunic.
- (2) Congenital type, communicating with the peritoneal cavity.
- (3) Infantile type, tunica vaginalis and a part of the

funicular process, distended with fluid, no connection with peritoneal cavity.

- (4) Inguinal type, hydrocele accompanies an undescended testicle.

## B. Encysted hydrocele of testis and epididymis.

- (1) Occurring as encysted hydrocele of the epididymis, where the two layers of the visceral tunica vaginalis pass from the testis to the epididymis.
- (2) Occurring between the tunica albuginea of the testicle and the visceral layer of the tunica vaginalis.

## 2. Hydrocele of the spermatic cord.

- A. Diffuse type, or serous effusion resembling edema of the cord.
- B. Encysted type, resulting from unobliterated portions, of the funicular process, or from the organ of Giraldes.

## 3. Hydrocele of the sac of a hernia, occurring where there is a serous effusion into the sac, the contents of which have been reduced with subsequent obliteration of the neck of the sac.

## 4. Various combinations of these three types of hydrocele.

Hydrocele is of rather frequent occurrence, comprising from 2 to 4 per cent of urological admissions. It is much more common in the tropics; some authorities state as high as 10 per cent. It occurs at any age, but is rare in infants. About 50 per cent of the cases occur after the age of forty years. Some writers suggest a causative relationship with the genital vascular changes incident to declining sexual func-

tion. The condition is bilateral in about 4 per cent of cases. In unilateral cases one side is involved about as often as the other.

etiological factor in this condition is difficult and in more than 50 per cent of the cases (311 or 502 in Campbell's series)

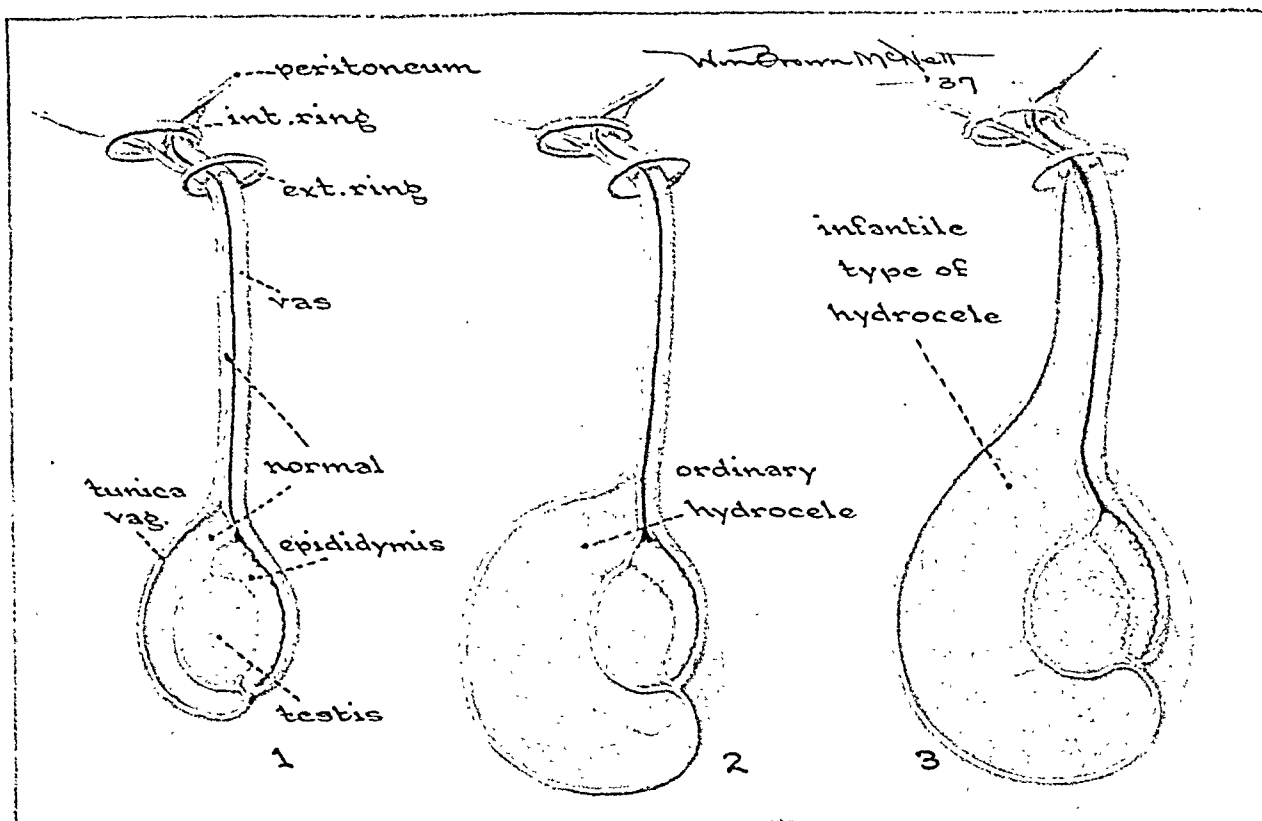


FIG. 1. Schematic drawing showing (1) normal relationship of the tunica vaginalis testis, (2) simple hydrocele; the most common type, (3) the somewhat rarer infantile type of hydrocele.

The condition may be acute or chronic. It may be symptomatic or idiopathic. Keyes reminds us that all of the symptomatic cases are not acute but that all of the idiopathic cases are chronic.

Infection of the epididymis or testicle and trauma to these structures or the spermatic cord are the principal causes of acute hydrocele. Young states that Francis Hagner encountered 31 instances of hydrocele while operating on 33 patients with acute gonorrheal epididymitis. It quite commonly follows operation for hernia or varicocele. It is said to be common during the course of the first year of inadequately treated syphilis. It may occur during the course of typhoid fever, pneumonia, etc. The acute and symptomatic types normally disappear spontaneously or after tapping, and treatment of the cause; or, they may persist as a chronic hydrocele.

Chronic idiopathic hydrocele is the type with which we are chiefly concerned. The

impossible to determine. As a rule the condition is insidious in its development. Campbell and others believe that chronic inflammatory change in the epididymis is the etiological factor in the majority of cases. Certainly, induration of varying degree is a usual finding on routine examination of the epididymis, of men passed the age of forty years. It is indeed difficult to find one in whom some palpable change may not be detected and it is certainly most common to find chronic changes at operation on these patients. I am inclined to agree with the theory of epididymal inflammatory reaction, but I have no proof to offer. The condition is said to be common among those whose occupation subjects them to scrotal trauma; cowboys and circus riders are examples.

The fluid in uninfected, uncomplicated hydrocele is clear and resembles urine. Its specific gravity is 1020 to 1026; it contains from 4 to 6 per cent of albumin, some

fibrinogen, sometimes cholesterol, a trace of glucose, salts, fibrin and occasionally fibrous bodies impregnated with lime salts.

careous plates. Occasionally villous growths are found, and when adhesions are present the sac becomes multilocular.

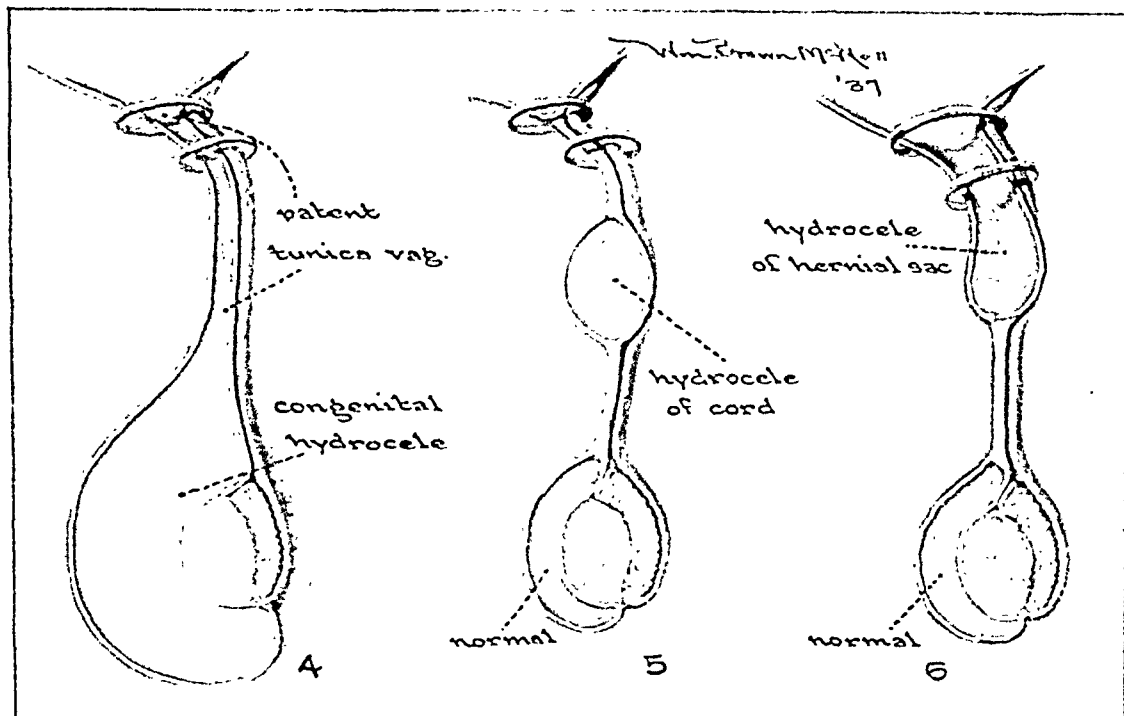


FIG. 2. Schematic drawing showing (4) congenital hydrocele, (5) hydrocele of cord, (6) hydrocele of hernial sac.

Microscopically the fluid contains a few endothelial cells, leucocytes, cholesterol crystals and lecithin bodies. Spermatozoa may be present, probably, as the result of rupture of a spermatocele into the sac, red blood cells, in the event of hemorrhage, and bacteria in the infected cases. Carforio reasoned that the fluid was an exudate because of its albumin content and high specific gravity. That the condition is seldomly found in connection with varicocele adds additional weight to this hypothesis. The character of the fluid changes with infection and hemorrhage. The quantity of the fluid varies from a few cubic centimeters to several hundred. Campbell, quoting Carforio, states that five gallons is the greatest quantity yet reported.

The wall of the sac may be thin and glistening, or, in older hydroceles, thick and leathery, and the serous surface covered with irregular fibrous, cartilagenous or cal-

Hydrocele may produce atrophy of the testicle in time as the result of pressure and possibly because of the interference with its thermoregulatory mechanism.

Pain varying with the etiology and rapidity of onset is often present in acute hydrocele, but is rare in the chronic type. The usual complaint in the chronic variety is a dragging sensation, and relief is often sought because of the inconvenience and unsightliness of the mass.

The diagnosis of chronic idiopathic hydrocele is usually not difficult. An accurate history is of very great value. The typical unilateral case presents a pyriform mass in the scrotum with the stem upward. The scrotal wall may be tense and shiny or appear normal depending on the quantity of fluid present. On palpation there is a tenseness and yet the mass is compressible and resilient. The testicle and epididymis are usually situated in a postero-inferior

position and may or may not be definitely palpable. They may, however, occupy an anterior position. The upper limit of the sac

predominate may transmit light and fluctuate. Biological tests may help. Gumma is suggested by the history, positive Wasser-

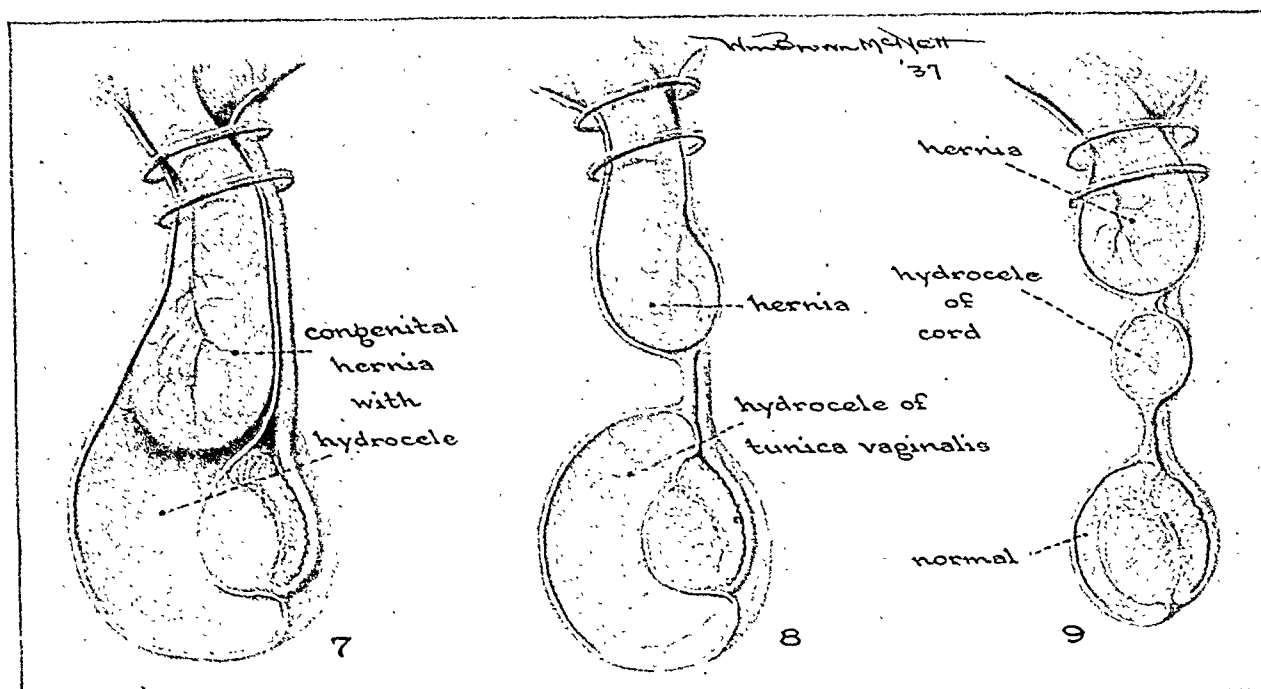


FIG. 3. Schematic drawing showing (7) congenital hernia with hydrocele, (8) simple hydrocele and hernia, (9) hernia and hydrocele of the cord.

may be outlined and the cord isolated proximally. There is no cough reflex transmitted into the sac. Finally, the sac is translucent, and when the testicle cannot be palpated, its shadow may be seen by transillumination.

Hydrocele must be differentiated from hernia, tumor of the testicle or epididymis, gumma, hematocele, spermatocele, cyst, and chylocele.

Transillumination may fail if the fluid is cloudy or bloody, in thickened sacs and in Negroes. It is sometimes demonstrable in cysts, certain tumors, and in hernia, especially in children.

Hernia should offer little diagnostic difficulty. Hernia and hydrocele may occur as separate entities while the former is often associated with congenital hydrocele. Tumor and hydrocele differ in consistency; the former is solid and heavy, the latter lighter and resilient. The history should aid in differentiating the two conditions. It must be remembered that some teratomata in which cartilage and mucoïd material

mann reaction, and other findings suggesting this disease.

Spermatocele may be associated with hydrocele and perhaps rupture into the sac. It may be single or multiple and cannot be diagnosed with certainty in every case; its position in relationship to the testicle and to the epididymis might help. The fluid in spermatocele contains little serum albumin, and the specific gravity is low (1002-1006) which differs considerably from the serum-like fluid of hydrocele. At any rate it is a matter of small importance if open operation is performed.

Hematocele may occur spontaneously. It is rare and usually due to trauma. It is remarkable that it does not occur more often as a sequel to tapping.

Chylocele, rarely encountered in the temperate zone, is a common complication of filarial infection. The aspirated fluid is milky and when allowed to stand, a layer of fat accumulates on its surface.

Hydrocele must be considered in the differential diagnosis of an abdominal mass

associated with undescended testicle. Congenital and infantile hydrocele may be associated with hernia and difficult to

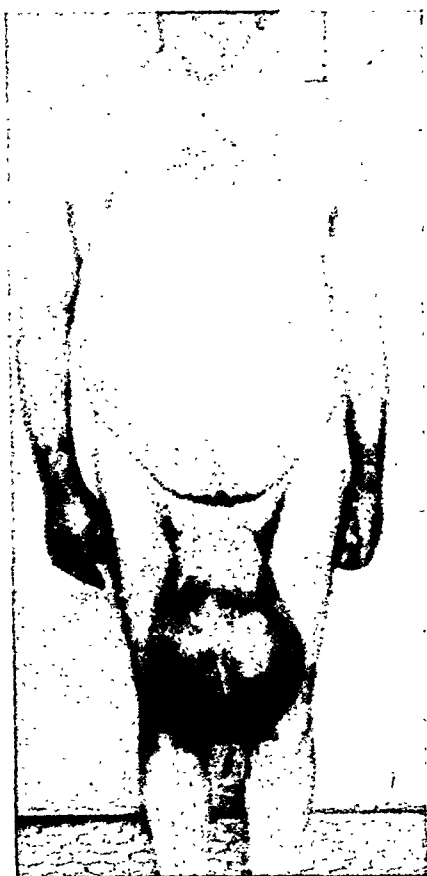


FIG. 4. Right idiopathic hydrocele of thirty years duration. Patient, aged fifty-five years, states that it had never been tapped. Note the complete disappearance of the penis. (Courtesy of Dr. M. B. Dewire.)

differentiate. The cough impulse is present. Transillumination is untrustworthy and tapping should not be done if there is doubt.

Diffuse hydrocele of the cord is difficult to diagnose with certainty; if there is a single or multiple cysts, it is comparatively easy. Transillumination is the only positive sign. The same applies to hydrocele of a hernial sac. A history of previous hernia is helpful. Lipoma of the cord may be confusing.

Abdominoscrotal hydrocele (hydrocele en bissac) is the rarest form of hydrocele. The method of its formation is not entirely

clear. It seems possible that it might be the result of an invagination of a simple hydrocele sac through the inguinal canal to burrow up between the peritoneum and anterior abdominal wall or between the pelvic peritoneum and pelvic wall. There is an hour-glass constriction where the sac passes through the inguinal canal. A fluid wave may be detected in one segment by pressure over the other, and both sacs may be emptied by tapping one of them. In all of the reported cases the patient has noted the scrotal swelling first, and apparently two to three liters of fluid may collect in the abdominal segment before it creates attention.

The treatment of hydrocele varies with the condition with which we have to deal. As has been mentioned the treatment of acute and symptomatic hydrocele consists largely in the treatment of the underlying pathology. Tapping may be indicated. The condition either disappears with the causative lesion, or persists as a chronic hydrocele.

The congenital hydrocele of infants usually disappears spontaneously. A small percentage may persist as such to adult life. The associated hernia occasionally demands attention. I encountered recently a strangulated hernia associated with congenital hydrocele in a very young infant.

The radical operative treatment of hydrocele is, in our experience, a most satisfactory procedure. Eversion of the sac is done, in suitable cases, with thin-walled sacs. If the sac is large, a portion is excised sufficient to permit approximation of its edges, behind the epididymis without leaving too much redundant tissue. Care must be used to incise the sac from pole to pole or there may remain a pocket that will refill. Partial or complete excision without eversion is appropriate for thick or unusually large sacs. If the epididymis is considerably diseased we do not hesitate to remove it; this makes for a much more satisfactory and cleaner operation. It cannot be stated too often that secondary

hemorrhage is a troublesome factor and that hemostasis at operation must be absolute. The high frequency coagulating current is useful for this purpose. We usually drain for twenty-four hours, the scrotum through a counter incision and have never seen troublesome secondary hemorrhage or infection follow its use. Postoperative hemorrhage may be very troublesome and is not infrequently followed by deep secondary infection with loss of the testicle in some instances, (8 times in Campbell's series).

We prefer inhalation or spinal anesthesia; local anesthesia is not entirely satisfactory and quite possibly contributes to the frequent occurrence of secondary infection, in certain reported series of cases.

Atrophy of the testicle is present in many cases before operation.

It is difficult to ascertain the effect of operation in this situation.

Hospitalization is necessarily longer following total excision of the sac than in simple eversion, and the irregular tender lump that persists in the scrotum for a long time following the former is disturbing to most patients.

Bruns noted recurrence in 2.4 per cent of 1216 operated cases.

The average hospitalization in Campbell's series was 9.4 days.

The principle of injecting sclerosing solutions into the sac of a hydrocele is a very ancient one. A great many substances, much too numerous to mention in this paper, have been employed. Among these, however, iodine which was introduced in 1832 by Martin seems to have been very widely used. One hospital reported 2393 cases treated within a seven year period soon after its introduction, with success, in practically all. This substance caused pain and a disability requiring confinement to bed of from eight days to several weeks in some cases. There was a considerable percentage of abscesses and sloughs. Recurrence, in general, was undoubtedly high. Phenol which was suggested some forty years later was less painful than iodine but

otherwise was open to the same objections, and in addition there were some cases of phenol poisoning reported. This method of treatment was largely discarded with the perfection of operative procedures, but since the introduction of sclerosing solutions in the treatment of varicose veins, a new interest has been awakened in the injection treatment of hydrocele. Killburne and Murray published a paper in 1932 which I think will come to be regarded as a classic. They state that the ideal solution must possess the following properties:

1. It must be painless.
2. It must not cause disability.
3. It must be efficient in destroying all hydroceles with recurrence.
4. It must not be dangerously toxic.
5. It should be bactericidal.
6. It must not subject the patient to the danger of hemorrhage into the sac following the injection.

After much experimental investigation, it was found that quinine hydrochloride 13.33 per cent and urethane 6.66 per cent meet very nearly the outlined requirements for the ideal solution. It is subject to the objection that while it will bring about a cure of hydrocele, it is not as efficient as a solution of quinine dihydrochloride 13 per cent. However, this solution causes some pain. Accordingly, they use the first solution for the first injection, and for subsequent injections employed the second solution, and state that these subsequent injections are painless.

One gathers the impression from the literature that these sclerosing solutions produce an obliteration of the sac by the production of fibrous tissue. This opinion, however, is not supported by open operation and actual investigation. Ewell and his co-workers operated upon one of their patients one month after the last of three injections with quinine hydrochloride and urethane; their findings were that,

There was a small amount of dark amber fluid and several long, loose strands of attached and organized fibrin. Grossly the testicle and epididymis appeared normal. Microscopic sec-

tion of the tunic wall showed the endothelium to be intact, the blood vessels appeared normal though the subserous layer of the tissue was distinctly thickened and infiltrated with organizing fibrous tissue.

From this one case they suspect that the resulting fibrosis of the tunic wall following injection so interferes with the blood and lymph supply of the endothelium, that in some way it alters the process of fluid formation or reabsorption.

The injection is done with a Luer type syringe and a needle of rather small caliber, 17 to 20 gauge. The skin is tunnelled before penetrating the tunic. After the sac has been completely emptied the fluid is examined microscopically for pus and blood, and careful palpation of the scrotal contents is done for detection of pathological changes in the testicle and epididymis. Two to 4 c.c. of the quinine and urethane solutions are injected, the needle withdrawn and by manipulation an effort is made to distribute the solutions throughout the sac. A snug bandage or suspensory is applied and the patient allowed to go his way. Fluid nearly always reaccumulates within one week after the first injection. The procedure is repeated at that time using quinine dihydrochloride, 3 to 10 c.c. Should fluid again form, an interval of three weeks is allowed before repeating subsequent injections. The fluid aspirated after the first injection is hazy and contains fibrin. Some cases require only one injection, but the average case requires two to three, and occasionally an even greater number is necessary. Should epididymo-orchitis develop, as it occasionally does, during the course of the treatment, it must be allowed to subside before continuing.

Injection treatment may be employed with safety and with assurance of good result in simple chronic sterile hydrocele. It is not indicated in the congenital variety or where there is serious pathology present in the testicle or epididymis. It is not suitable where haste is a necessity. Sacs of 1200 c.c. capacity have been treated successfully by injection. The procedure is

simple and may be readily carried out as an office procedure. Few require sedatives or confinement to bed.

There have been, as yet, no large series of cases reported. There are, however, many small series and the results compare favorably with the reports of the operated cases.

An assistant is desirable and almost a necessity in tapping and injecting a hydrocele. I find very frequently that it is impossible to drain the sac completely even with assistance. This fact is believed to be responsible for some of the failures when injection is done. I do not believe that injection treatment should be substituted for radical operation under usual circumstances.

In a certain number of patients tapping alone seems to be the desirable form of treatment for one reason or another. It does not affect a cure. We have a number of patients whom we have tapped, at intervals of from three to nine months, over a period of ten years, and there has never been a complication following this procedure.

#### VARICOCELE

Varicocele may be defined as an affection of the veins of the pampiniform plexus comparable to varicose veins occurring in any other part of the body. We recognize a symptomatic and idiopathic type of varicocele.

The symptomatic type is rare, occurs usually in older men, involves either side with equal frequency and causes little or no discomfort. This type develops promptly and may attain large size. The veins empty slowly, if at all, when the patient is recumbent. Symptomatic varicocele is caused by mechanical pressure exerted on the spermatic vein either within the inguinal canal or the abdominal cavity. The condition is most often produced by tumors of the kidney but may be caused by any retroperitoneal mass, by a hernia, a truss or tumor in the inguinal canal.

Idiopathic varicocele is said by some writers to be present in from 15 to 20 per

cent of all young adults, while others state that it is present in some degree in practically all. It is generally believed that the sexual influence is the most important factor; the anatomical arrangement of the left spermatic vein and perhaps an hereditary influence play some part.

The condition develops slowly and affects the left side in practically all of the cases, may occur bilaterally, but rarely on the right side alone. It occurs most frequently during the age of greatest sexual potentiality (90 per cent between fifteen and thirty-five years in Campbell's series) and commonly disappears or causes no inconvenience after marriage, or with advancing years. These common observations are the basis for the belief that the congestion attending ungratified sexual desire and perhaps, in some cases, overindulgence are responsible for the condition in the majority of patients.

Theoretically the left sided preponderance has been explained on the basis of the anatomical variations in the right and left spermatic veins and on the common observation that the left testicle hangs lower than the right.

Some consideration has been given to the influence of heredity as a factor in the cause of varicocele. Barney believes that it has some connection, other authorities doubt this.

Violent muscular effort may produce acute varicocele by damage to the valves in the veins. Campbell recognized the condition 3 times in his series. It may be extremely painful and mimic acute epididymitis.

The pampiniform plexus is composed of three groups of veins, a posterior cremasteric, a middle deferential and an anterior spermatic group. Any or all of these veins may be involved in a varicocele, usually it is the larger spermatic group.

The condition is characterized by tortuosity and dilatation occurring primarily, later endophlebitis, thickening, fatty infiltration, thrombosis and phlebolith formation in some cases. The blood supply of the

testicle may become so impaired by these changes that atrophy develops (about 1 per cent, Campbell; 11.5 per cent, Barney).

There is a great variety of subjective complaints presented by those affected with varicocele; a dragging sensation with or without pain is common. Many state that the condition is worse in hot weather or on exertion. A fear of impotence is present in many cases together with a variety of subjective symptoms that we usually associate with sexual neurasthenia. A large percentage have no symptoms.

The diagnosis of idiopathic varicocele is usually obvious on inspection, the dilated tortuous veins and a relaxed scrotum with low hanging left testicle are characteristic. The veins empty rapidly in the recumbent posture and refill promptly on standing. Omental hernia may possibly be mistaken for varicocele on inspection alone but is easily differentiated by first reducing the mass in the recumbent posture and retaining it within the abdomen with a finger pressed over the external ring while the patient stands.

The "bag of worms" felt on palpation is characteristic of varicocele. The condition may be associated with hernia (40 times in Campbell's series) or hydrocele, but this should offer no difficulty in differentiation.

Idiopathic varicocele is asymptomatic in the majority of cases and it is a common observation that symptoms disappear, and the varicocele as well, with marriage or when sexual activity begins to decline.

The condition may be divided roughly into three groups with reference to treatment, (1) the asymptomatic in which no treatment is required; (2) those with scrotal enlargement who complain of a feeling of weight or a dragging sensation in the scrotum or referred elsewhere. A suspensory should be tried. If this fails to bring relief, operation is indicated. (3) Those with sexual neuroses, and a small varicocele with or without symptoms referable to it. Operation is not advised in this group. These patients benefit in proportion to the confidence that their medical adviser is



able to instil in them. They must be told the facts. A sympathetic attitude, patience and time will affect a cure.

With this grouping used as a criterion, we operate upon comparatively few varicoceles.

The operation may be successfully performed under local anesthesia with slight inconvenience to the patient. Most of our patients choose some inhalation anesthetic, however. We prefer a combined inguinal and scrotal incision. The cord is exposed, the anterior group of vessels isolated and a section removed from them. Double ligatures are applied to both stumps after gentle crushing. Due care must be exercised in preserving the deferential circulation. We sometimes sew the cut ends of the stumps together with fine catgut but more generally employ the method of suspending the testicle devised by Vincent and described by Keyes in his textbook. We have not found abbreviation of the scrotum necessary, it usually becomes less redundant after operation. We do not employ drainage postoperatively.

The most serious complication is hemorrhage. We have not encountered it. Various observers have found that hydrocele follows operation in 23 to 30 per cent of cases. We have no figures on our cases but do not believe that it will even approximate such figures. Some have advocated eversion of the tunica vaginalis at the time the varicocele is attacked, but we do not agree that this is necessary or desirable. Atrophy occasionally occurs following operation. Its cause is not known but one always wonders about the preservation of the testicular circulation where it occurs. Campbell noted atrophy 3 times in 43 followed cases, while Douglas encountered it only 4 times in a followed series of 116 cases. Infection may occur and is quite likely to if there is secondary hemorrhage. Acute epididymitis occasionally follows operation.

A firm scrotal bandage is desirable postoperatively and a suspensory should be worn for a period of two weeks. Confine-

ment to bed is required for five to seven days postoperatively.

Injection of the anterior group of veins after exposing and doubly ligating them has been advocated. It is claimed that the resulting fibrous cord makes a good suspension for the testicle. I have had no experience with the method, but it does not seem to me to be a rational procedure.

#### SUMMARY

Since the introduction of the newer types of sclerosing solutions in the injection treatment of hydrocele, it is now a practical procedure with definite advantages over radical surgical treatment in some instances. The procedure will affect a cure in a high percentage of cases and causes very slight inconvenience to the patient. We prefer radical surgery in the usual case, reserving injection treatment where the circumstances seem to justify its use.

We cannot see any advantage in the injection treatment of varicocele. A relatively small proportion of varicoceles requires operative treatment. In those cases in which operation is indicated, the results are as a rule satisfactory.

#### REFERENCES

- BARETZ, L. H. *Med. Times and Long Island Med. Jour.*, 63: 9-14 (Jan.) 1935.  
BARNEY, J. D. *Pub. Mass. Gen. Hosp.*, 3: 335, 1910.  
CAMPBELL, M. F. *Surg. Gynec. and Obst.*, 45: 192-200, 1927.  
CAMPBELL, M. F. *Surg. Gynec. and Obst.*, 47: 4, 1928.  
EISENDRATH and ROLNICK. *Text Book of Urology*. Phila., Lippincott Co.  
EWELL, SARGENT and MARQUART. *Wisconsin Med. Jour.*, 34: 451-456, 1935.  
HENNINGER, H. *Urol. and Cutan. Rev.*, 38: 1934.  
HINMAN, FRANK. *Principles and Practice of Urology*. Phila., W. B. Saunders Co., 1935.  
KEITZER, W. A. *Jour. Mich. State Med. Soc.*, 35: 1689 (March) 1936.  
KEYES, E. L. *Urology*. New York, D. Appleton & Co., 1928.  
KILBOURNE, N. J. and MURRAY, CHAS. J. *California and West. Med.*, 37: 1932.  
LUBOWA, IRWIN. *Med. Rec.*, 143: 490-491 (June) 1936.  
NELSON'S SURGERY. New York, Thos. Nelson & Son.  
FLOYD, E. and PITTMAN, J. L. *Jour. Med. Assn. Georgia*, 23: 63-66, 1934.  
ROLNICK, H. C. *S. Clin. N. Am.*, 15: 757-766, 1935.  
SOLLEY, F. W. *S. Clin. N. Am.*, 16: 867-870 (June) 1936.  
TANZER, RADFORD C. *Jour. Urol.*, 34: 447-452, 1935.

# VAS DEFERENS: OPERATIVE TREATMENT

SIMON A. BEISLER, M.D.

Associate in Urology, College of Physicians and Surgeons, Columbia University; Assistant Surgeon, Squier Urological Clinic, Presbyterian Hospital; Urologist, Roosevelt Hospital

NEW YORK

**S**URGICAL procedures performed upon the vasa deferentia may be classified as follows: (1) for eradicating infection; (2) to prevent infection; (3) for relief of sterility; (4) for sterilization and (5) for injuries and neoplasms. It necessarily follows that frequently other parts of the seminal tract are involved and will be mentioned when necessary.

## PROCEDURES FOR ERADICATING INFECTION

*Vasostomy.* This was first described by Belfield in 1905 as a method of treating infections of the spermatic tract, especially the vesicles, with antiseptics. His original operation was done under local anesthesia, the skin incision being made at the upper end of the scrotum, the vas identified, its sheath incised, the vas isolated for 2 to 3 cm. and its lumen opened by a small longitudinal incision. Patency of its lumen was next determined by passage of a horsehair, which in an unobstructed vas should pass about 20 cm. If the vas was unobstructed, either a blunt needle or a cannula was inserted into the lumen, left in place, and 3 to 6 mils of collargol was slowly injected, as it was found extremely irritating to the interstitial tissues. At a later date the original operation was modified and the vas opening was anchored to the skin with a horsehair in situ as a guide. Irrigations were given once or twice daily from one to several weeks. The procedure was taken up by many others and the various inorganic and organic silver, as well as mercurial preparations, were used. Later Belfield tested patency with a 1:25,000 solution of methylene blue, which in a short time appeared in the urine.

Various modifications of Belfield's operation appeared, most notable of which were Kidd's and Luys'. These modifications were brought out in an attempt to overcome the marked interstitial reaction due to reverse flow of the chemical, its accompanying cicatricial formation and resultant sterility. Kidd's modification consisted of making a minute opening into the lumen of the vas with a small tenotome. After proving the patency of the vas with fine silkworm gut, the exposed vas and surrounding tissues were well protected by gauze. A No. 20 gauge needle with a tight fitting syringe was inserted into the lumen and 5 to 10 mils of colloid silver was injected. The opening into the vas was closed with one or more fine 00 catgut sutures through its outer layers, the vas replaced and the skin was closed by catgut sutures. Usually one injection was sufficient. Where necessary a second injection was given one week later by opening the vas at a higher level. In Luys' operation of vasopuncture the vas was opened with a fine pointed trocar and cannula. Through the latter patency was tested and the injection then made. Belfield, Barney and others used the vasostomy procedure as a means of injecting opaque material for roentgenological studies of the vasa and seminal vesicles. Later this was replaced by catheterization of the ejaculatory ducts and direct injection of the opaque medium (sodium iodide and skiodan) into the vesicles.

Much work was done along this line of treatment from the time of Belfield's original report in 1905, particularly where the main focus was found or thought to be in the seminal vesicles and resulting in recurring epididymitis, arthritis and recurring urethritis, until around 1925. While

certain investigators worked along this plan of treatment, others believed the more rational plan was to perform either seminal vesiculotomy or vesiculectomy. Selected cases for vasostomy were reported as giving 50 per cent cures, however, the procedure has lost a good deal of its earlier popularity. At the Squier Urological Clinic from 1928 to date only 2 vasostomies were performed, no seminal vesiculectomy for an infectious process and only 11 seminal vesiculotomy operations for suppuration were performed.

The vas deferens may be infected by extension along its wall or sheath. The vas may become infected from the epididymis or the seminal vesicles. Infections likewise may travel from the seminal vesicle through the lumen of the vas to the epididymis or vice versa without clinical evidence of involvement of the vas. Frequently in severe epididymitis the wall of the vas into the inguinal region is involved by continuity. Anatomically the sheath of the intrascrotal and intrapelvic portions of the vas merge into loose connective tissue at the level of the internal inguinal ring (Bogros's space). Seminal vesicle infections travelling along the sheath of the vas may give rise to tender indurated swellings or abscesses. The former may be confused with incarcerated inguinal hernia. Occasionally these sheaths of the vas are continuous and infections extending along the sheath enter the tunica vaginalis. When infections extend along the sheath all structures of the spermatic cord become involved and this is classified under funiculitis. Vasitis or deferentitis is most frequently associated with gonorrheal or other types of epididymitis and in these cases the entire wall of the vas is thickened. Where abscess is present incision and drainage is performed; where in doubt the condition is to be observed. When there is no question of abscess, bed rest and ice bags or diathermy may be indicated. In addition to treatment directed to the vas other involved parts should receive appropriate care.

#### PROCEDURES TO PREVENT INFECTION

In the nineteenth century ligation of the vas as well as castration was employed unsuccessfully as a means of overcoming prostatic hypertrophy by such workers as Cowper, Curling, Pasteau, Pousson, Albaran and Guyon. Squier in an article on prostatectomy in the *Medical News*, February, 1905, suggested vasectomy as a prevention of epididymitis and is quoted herewith:

We offer as a suggestion for the prevention of this complication ligation of the vasa deferentia prior to performing prostatectomy. It is but the work of a moment and would not materially prolong time of the operation. When severe cystitis exists it may prove especially efficacious, as these are the cases in which epididymitis is most prone to occur.

Proust makes a point of isolating and ligating the ejaculatory ducts before the removal of the prostate. It no doubt acts the same as ligation of the vasa, but requires more time to do as well as an elaborate dissection. We do not recommend that ligation of the vasa deferentia should be a routine procedure, but it may be found to be advantageous where the debility of the patient is so great that the possibility of testicular inflammation would greatly affect the prognosis.

In the latter part of the nineteen-twenties this suggestion first received considerable attention from Colston, Goldstein, Alyea, Crabtree, Brodny, Abeshouse and others. Today it is very commonly employed before even instituting preparatory treatment for prostatectomy or transurethral prostatic surgery.

These operations are variously termed as ligation of the vas, vasoligature, vasectomy and division of the vas and are performed to prevent infection that might extend through the vas, its sheath or lymphatics (?) from the prostate, its fossa, or the seminal vesicles to the epididymis and testicle or in the reverse manner. The more common method employed consists of an excision of a small segment, about 2 to 3 cm. The procedure can be readily carried out under local anesthesia. The vas is

grasped between the thumb and index or middle finger at the level of the incision, which is usually made on the anterior surface of the scrotum just below the scroto-abdominal junction. The vas is separated from other contents of the cord and ligated in two places, a small segment of 2 to 3 cm. is excised, the stumps replaced and the skin closed with two to three interrupted sutures without drainage.

The value of vasectomy as a preliminary to prostatectomy, transurethral prostatic operations and other protracted bladder operations can readily be seen by the following reported figures: Crabtree and Brodny in 1930 collected 1624 reported cases of prostatectomy without previous vasectomy, 21.6 per cent of which developed epididymitis, while in 514 cases in which vasectomy was performed, only 8 cases of epididymitis developed, or a percentage of 1.50. In 1936 Abeshouse reported 208 cases of prostatectomy with preliminary vasectomy without a single case of epididymitis. Recently the author reviewed the cases at the Squier Clinic from 1931 to 1935 inclusive, 414 cases of prostatectomy without vasectomy developed 49 cases of epididymitis, 5 of which required incision and drainage, making a percentage of 11.8 of epididymitis, 10.2 per cent of the latter requiring incision and drainage. During the same time 187 cases of prostatectomy had vasectomy performed and developed only 9 cases of epididymitis, 4 of which, however, required incision and drainage. This makes a percentage of 4.81 of epididymitis, 44.4 per cent of which required incision and drainage. At the Squier Clinic we believe vasectomy should be employed early in the course of preparation for prostatectomy or otherwise it may light up a pre-existing focus which may go on to suppuration. The variation in the percentages of epididymitis with or without vasectomy vary directly with economic factors. Private patients show the least involvement. Ward patients in a city or state hospital give the highest percentage of epididymitis.

Various other operations have been described by Alyea, Colston, Morson, Darget, Labot and others. Alyea and Colston, using special clamps and needles, ligate the vas through the scrotum without making an incision. Morson instead of ligating the surgically exposed ends of the vas crushes them between artery clamps. Darget and Labot employ a single anterior vertical midline incision along the median raphe of the scrotum for exposure and division of the vasa.

While primary tuberculous involvement of the vas apparently does not occur, it is secondarily involved from the epididymis and seminal vesicles. It is not in the scope of the paper to bring up factors for or against where the primary focus of tuberculosis in the lower genitourinary tract occurs. Radical removal of the entire lower genitourinary tract seems to have lost much of its prestige. To-day, however, it is common practice in removing a tuberculous epididymis to do a vasectomy on the uninvolved side, even in the absence of proved involvement of the prostate or seminal vesicles. Vasectomy is also done bilaterally in cases of proved prostatic or seminal vesicle involvement, without definite evidence of invasion of the epididymis. Barney has shown that these cases of tuberculosis are usually sterile.

#### FOR RELIEF OF STERILITY

These operations have been devised to overcome mechanical obstructions which prevent the passage of spermatozoa from the testicle or epididymis through the vas to the ampulla and vesicle. In azoospermia the condition is either bilateral or unilateral with the opposite side absent or atrophied. The operations described consist of anastomosis between the vas and epididymis, between the vas and testicle, between the vas and a spermatocele and crossed anastomosis of one vas to the opposite epididymis or testicle. Success, in addition to the operative technique, depends on proving the patency of the vas deferens above the obstruction as well as finding viable

spermatozoa in either the epididymis or testicle below the obstruction. Failures from the operative standpoint are not only due to the very small calibre of the lumen of the vas and the brittleness of epididymal tubule, but also to the fact that hemorrhage, tension of suture and infections can easily give rise to sufficient scar tissue to obstruct the new passageway. It is important also to know the status of the ampulla and seminal vesicle.

In 1902 Martin and his associates described the first laterolateral anastomosis of the vas to the epididymis. This was followed by modifications by a number of men such as Fuller, McKenna, Lespinasse, Quinby, Bogoljuboff, Hagner and others. Fine silk, silkworm gut, silver wire with occasional addition of catgut are the favorite suture materials. Direct anastomosis of the vas to the epididymis is almost impossible because of the microscopic size of the tubule of the epididymis. Because of the latter the vaso-epididymostomy operations require removal of an oval or cup-shaped piece of tubule and thereby hoping the anastomosis will develop from one of the convolutions.

*Hagner's Operation.* Hagner exposes the entire epididymis by opening the tunica vaginalis. He tests the patency of the vas with a fine tear duct probe, which should pass 16 to 20 cm. At a point in the epididymis where viable spermatozoa are obtained an elliptical piece is excised and laterolateral anastomosis is made with fine silver wire. The first silver wire suture is used for anchorage and is placed between the distal end of the opening into the vas and the lower end of the elliptical incision. Two lateral sutures are used and care should be exercised to include some of the cut tubules of the epididymis and prevent their dropping back. These sutures should include just enough of the opening into the vas to approximate the edges of the anastomosis. In placing the last suture, which approximates the upper ends of the incision in the epididymis and the vas, one should be careful not to occlude the lumen.

Before this suture is tied patency should be tested with the fine tear duct probe. From Hagner's experience manifestations of successful operations vary up to nine months, and, therefore, he waits one year before undertaking a second anastomosis. He has had good end results in 21 of 33 cases operated or in 63.6 per cent.

*Anastomosis of Vas Deferens to Spermatocoele.* Spermatocoeles are common and may be present with occlusion of the epididymis. Lateral anastomosis or direct implantation of the cut end of the vas into the spermatocoele sac offers excellent chance of success. Hagner reported a successful lateral anastomosis of this type, which six weeks postoperatively had live spermatozoa, and his wife gave birth to a child within one year.

*Crossed Anastomosis of Vas.* Hagner reported this type of anastomosis in 3 cases in which viable spermatozoa were found in the epididymis but the corresponding vas was occluded, while the opposite vas was patent but without spermatozoa in its epididymis. In these cases the patent vas is severed at the lowest feasible point and passed through the median septum of the scrotum and anastomosed to the epididymis.

*Anastomosis of the Vas to the Rete Testis.* This type of anastomosis was unsuccessfully attempted and reported by Scaduto in 1901. The first successful ones were reported by Bogoljuboff in 1903. The original operation was modified by Rolnick on the basis of experiments on dogs. In Rolnick's operation the vas is lifted out of its sheath  $1\frac{1}{2}$  inches above the point it crosses the mediastinum of the testicle. A small longitudinal incision is made in the vas and its patency tested. A blunt vasotomy needle is then inserted through this opening downward toward the epididymis and the vas is divided over the needle where it crosses the mediastinum of the testicle. The upper end of the vas is split into two or three parts and 000 catgut sutures inserted through the split ends with a No. 23 gauge hypodermic needle. The

vasotomy needle in the vas is threaded with a fine silkworm and then removed. A long No. 23 gauge hypodermic needle is inserted through the posterior convex surface of the testicle with its point emerging at the rete in the mediastinum. At this point of emergence the tunica is split for a distance of  $\frac{1}{4}$  of an inch, the rete incised and tested for spermatozoa. The needle through the testicle is threaded with the same silkworm which has passed through the lumen of the vas and withdrawn, so that the silkworm now passes through the testicle and vas. The sutures in the split end of the vas are united to the tunica of the testicle which has been incised, the ends of the vas dipped into the rete and the sutures tied. The silkworm is carried out on the skin on both sides and then tied. It is left in place seven to ten days. The purpose of this silkworm gut is to develop a channel, prevent organization of a scar, make a path for the process of epithelialization and to fix the testicle and vas and thus avoid tension. The introduction of the silkworm gut suture for these purposes was first brought out by McKenna in his work on epididymovasostomy.

Wilhelm in 1935 has suggested and described a two-stage vaso-orchidostomy with interposed spermatocele.

#### OPERATIONS FOR STERILIZATION

The subject of sterilization has gained increased prominence through legislation not only in several European countries but also in states in this country. The compulsory aspects of these legislations apply usually to the physically and mentally defective public charges, as well as all persons with outward evidence of hereditary disease. It is well to remember that, dependent on the circumstances, consent for human sterilization may be given by the patient, by the patient with his parents or guardian, may be ordered by state officials and that it may be forbidden by law, as four states limit by penal statutes sterilization in private practice to cases of "medical necessity." Twenty-eight states

have laws providing compulsory or voluntary sterilization of mentally deficient persons. Whenever the question of sterilization arises in marriage because of a pathological condition it would seem more logical to sterilize the so afflicted individual. The latter opinion at times may have to be varied after consultation with the internist. The question of sterilization of a healthy male is, however, a problem of his own to be discussed with his physician.

The operations performed for sterilization have been described under procedures to prevent infection. Whenever this operation is performed for sterilization it is highly advisable to excise 4 to 6 cm. of each vas, appropriately label the section from either side and request a histological section of the same. Another caution is, that the semen should be checked at intervals for spermatozoa, as they can at times remain viable within the vesicles for lengthy periods. Wildenskov advocates injection of a sterilizing agent such as 0.1 per cent rivanol, into the vas above the resection. Steinbach in 1912 advocated vasectomy for impotency in the elderly male, claiming it caused proliferation of the interstitial cells, with an increased production of the male hormone. This to date has not been proved and has been widely criticized.

#### OPERATIONS FOR INJURIES AND NEOPLASMS

Injuries of the vasa are not at all common. Injuries more likely to occur are those due to accidents in operations involving the spermatic cord where the vas may be partially or completely severed. When recognized the partially or completely severed vas should be immediately repaired by two or more fine silk or silver wire sutures, care being taken not to include the lumen. Another method of suturing frequently employed is to pass a piece of fine silkworm gut threaded to a needle into the lumen of both ends of the vas and out through the wall for a distance of 1 cm. Having thus approximated the divided vas, the ends of the suture are tied loosely

over the skin and after seven to ten days are cut and removed. The sheath of the vas should always, if possible, be reunited. Other operative injuries are those following the use of strong chemicals in vasostomy procedures. Infrequent injuries occur in stab wounds, bullet wounds and blows. In the latter, injuries to the blood vessels are more likely to occur than to the vas itself and the treatment is similar to wounds in general.

Neoplasms of the vas deferens are extremely rare. Cysts such as spermatoceles occasionally occur. Fibroma is occasionally seen and more likely arises from the spermatic cord. A few cases of lipoma and one of sarcoma have been reported. Other malignancies along the course of the vas are usually extensions from primary growths from within the scrotum. The operative treatment in benign growths is local excision and in malignancies dependent on the degree of involvement either radical surgery, deep x-ray therapy or a combination of both.

#### SUMMARY

Vasostomy, like seminal vesiculotomy and seminal vesiculectomy were popular operative procedures from 1905 through 1925. Since then they have lost a great deal of their popularity with resultant greater selectivity of cases.

The most common operation on the vas deferens, ligation of the vas, is mainly employed preliminary to prostatectomy, whether performed by the open or closed methods, and preliminary to extensive bladder or urethral manipulations, as a preventative to epididymitis. It is also employed in cases of tuberculosis where the prostate, seminal vesicle or one epididymis is involved, hoping to prevent spread to the

uninvolved epididymis. Ligation of the vas is employed in sterilization of the male.

Operations for the relief of sterility have to overcome the mechanical obstructions which prevent the spermatozoa from traveling from the testicle and epididymis through the vas to the ampulla and vesicle, which necessarily have to be varied, dependent upon operative findings in each case.

Neoplasms benign or malignant of the vas deferens are rare and seldom primary. Likewise injuries are uncommon.

#### REFERENCES

- ABESHOUSE, B. S. *Am. Jour. Surg.*, 32: 8-16, 1936.  
 ALYEA, E. B. *Jour. Urol.*, 19: 65, 1928.  
 BARNEY, J. D. *Tr. Am. Assn. Genito-Urinary Surg.*, 9: 72, 1914.  
 BARNEY, J. D. *Am. Jour. Surg.*, 28: 471, 1914.  
 BELFIELD, W. T. *J. A. M. A.*, 44: 1277, 1905; 61: 1867, 1913; 74: 148, 1920; *Jour. Urol.*, 14: 349, 1925.  
 BELFIELD, W. T. and ROLNICK, H. C. *J. A. M. A.*, 1913; *Jour. Urol.*, 16: 73, 1926.  
 BELT, E. J. *A. M. A.*, 102: 396, 1934.  
 BOGOLJUBOFF, V. *Semaine Medicale*, 1924; *Mett.* I and II. *Arch. f. Klin. Chir.*, 70: H. 3, 1902; 72: 449.  
 COLSTON, J. A. C. *J. A. M. A.*, 90: 526, 1928.  
 CRABTREE, E. G. and BRODNY, M. L. *Tr. Am. Genito-Urinary Surg.*, 23: 383, 1930.  
 DARGET, R. and LABOT, P. *Bull. Soc. franç. d'uro.*, p. 234, 1933.  
 FULLER, E. *Jour. Cutan. and Genito-Urin. Dis.*, 14: 329, 1896; *Med. Rec.*, p. 717, 1909.  
 GOLDSTEIN, A. E. *Jour. Urol.*, 12: 25, 1927.  
 HAGNER, F. R. *Surg. Gynec. and Obst.*, 52: 330, 1931; *J. A. M. A.*, 107: 1851, 1936.  
 KIDD, F. S. *Lancet*, 2: 213, 1923; 2: 28, 1928.  
 LESPINASSE, V. D. *J. A. M. A.*, 70: 448, 1918.  
 LUYS, G. *Clinique, Paris*, 8: 34, 1913; *Cong. d'uro.*, 1921; *Paris, G. Doin et Cie.*, 1930.  
 MARTIN, CARNETT, LEVI and PENNINGTON. *Univ. Penn. Med. Bull.*, 15: 2, 1902.  
 MCKENNA, C. M. *J. A. M. A.*, 64: 2127, 1915.  
 MORSON, A. C. *Brit. Med. Jour.*, 1: 54-55, 1933.  
 QUINBY, W. C. *Boston Med. and Surg. Jour.*, 155: 539, 1906.  
 RANDALL, A. *Jour. Urol.*, 16: 141, 1926.  
 ROLNICK, H. C. *Jour. Urol.*, 12: 445, 1924; 14: 371, 1925.  
 SQUIER, J. B. *Med. News*, 86: 294, 1905; *Boston Med. and Surg. Jour.*, 170: 908, 1914; *New York Med. Jour.*, 101: 333, 1915.  
 WILDENSKOV. *Ugesk f. Laeger.*, 98: 104, 1936.  
 WILHELM. *Arch. Surg.*, 30: 967, 1935.



# OFFICE TREATMENT OF BARTHOLIN'S GLAND ABSCESS OR CYST

ALBERT MATHIEU, M.D.

Associate Professor of Obstetrics and Gynecology, University of Oregon Medical School; Attending Gynecologist,  
Multnomah Hospital

PORTLAND, OREGON

**B**ARTHOLIN'S gland abscess or cyst can be treated satisfactorily in one's office with a minimum of expense and

## BARTHOLIN'S GLAND ABSCESS

The red, painful and fluctuating swelling in the region of the Bartholin's glands is



FIG. 1. The gland is held firmly between the thumb and the index finger. An incision, about 1 cm. long, is made through the skin in the dependent portion of the mass in the region of the duct. In case of abscess of Bartholin's gland, the incision is made in the same place, but it is made a little bit longer and extends into the gland itself. When the pus is evacuated, a small gauze strip is inserted to keep the incision from closing prematurely.

discomfort to the patient. I have used the procedures described here for six years and have found them to be simple, safe and curative.



FIG. 2. The heated blade of a Post cautery is thrust through the opening in the gland, and the lining of the gland is destroyed by vertical and horizontal movements with the blade tip.

diagnostic of Bartholin's gland abscess. There is only one treatment for this condition, incision and drainage.

Under local ethyl chloride anesthesia the incision is made at the dependent portion of the gland, near the mucocutaneous border. The abscess should not be squeezed or massaged after the incision has been



made. A small gauze strip is then inserted into the opening, and it is replaced with a clean one every other day for three or

stroyed, and following incision and drainage there is a permanent cure. However, in many cases the mucous membrane lining of the gland does not lose its ability to secrete mucus, and if the duct remains closed there will ensue a Bartholin's gland cyst which will slowly enlarge to the point of producing great inconvenience.

Bartholin's gland cyst is treated in the following manner: Under intravenous evipal or pentothal sodium, or under nitrous oxide or ethylene anesthesia, after aseptic and antiseptic precautions, the cyst is grasped between two fingers and an incision, approximately 1 cm. in length, is made through the skin, as near the duct opening as possible (Fig. 1). Through this incision the hot blade of a Post cautery is inserted into the cyst, and, then, by a series of vertical and lateral strokes, the entire wall of the cyst is destroyed by actual cautery (Fig. 2). If the incision is made close enough to the opening of the duct, the duct will also be destroyed. No packing is necessary as the cauterized edges of the incision will remain open until the entire site of the cauterization has healed. There is no bleeding and only slight discomfort following this procedure. The entire operation can be done in about three minutes, and within two or three hours the patient is able to get up and walk home.

The wound heals slowly by granulation from its base, and in one week has the appearance shown in Figure 3. During this time there is practically no discomfort to the patient. At the end of one month the wound is closed and healed with a hardly perceptible scar.

#### SUMMARY

An office method of treating Bartholin's gland abscess and Bartholin's gland cyst is shown. The cyst lining is destroyed by means of the Post cautery through a small incision, and illustrations are given to demonstrate the method.

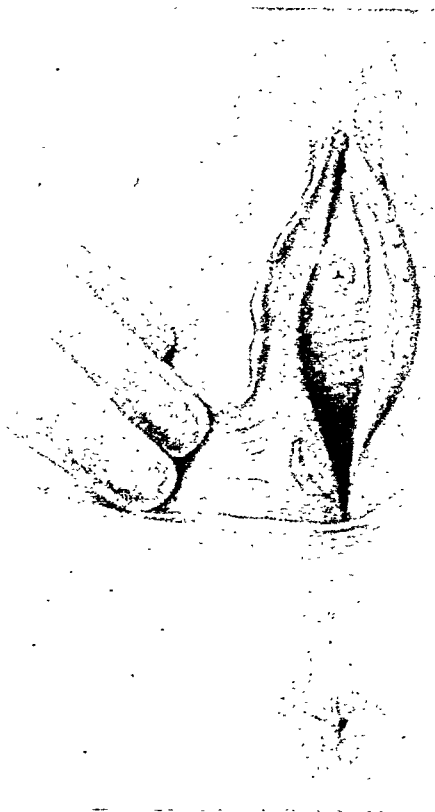


FIG. 3. The wound one week after the cauterization. Drainage continues through this opening and the healing takes place from the base of the wound. In one month or less the wound is healed.

four times. This insures adequate drainage and prevents the incision from closing too early.

The physician must know that this is merely an emergency treatment and that when the wound has healed, if the duct of the gland does not reopen, the continued function of the gland may lead to the formation of a cyst. He should inform the patient of this, and instruct her to return for removal of the cyst if one should form and cause her inconvenience. He should also tell the patient that there are two Bartholin's glands.

#### BARTHOLIN'S GLAND CYST

In many cases of Bartholin's gland abscess the gland and its duct are de-

# IMPERFORATE HYMEN\*

MAURICE O. BELSON, M.D.

Assistant Gynecologist and Obstetrician, Carney Hospital; Gynecologist, Beth Israel Hospital; Assistant Surgeon, Department of Gynecology, Boston Dispensary; Assistant in Gynecology, Tufts College Medical School

BOSTON

**I**MPERFORATE hymen is a malformation of real clinical importance even though it is not very common. Nelson,<sup>1</sup> in his report of a case of congenital atresia due to imperforate hymen, refers to the 36 collected cases reported by Ross in the American Medical Journal of July, 1891, which reviewed the literature up to that time. Murphy in the British Medical Journal reported one case in 1895. A survey of the literature from 1916 to 1936 reveals 37 reported cases.

## ANATOMY

The hymen is a thin membranous fold partially closing the lower end of the vagina, separating the vagina from the vulva, and is perforated usually at the center. The structure of the hymen is similar to that of the vagina and is composed of connective tissue with numerous elastic fibers, blood vessels, occasional nerve endings, and is covered on either side with stratified epithelium. The opening in the hymen varies in size and shape, giving rise to different types depending on the pattern of the opening. The more common types are: the semilunaris, the annularis, the cribiform, the septate, the denticulata or fimbriata and the imperforate. These are self-explanatory. The fimbriated hymen may sometimes be mistaken for a ruptured hymen and possesses some medicolegal interest.

In the newborn the hymen is redundant and projects beyond the surrounding parts. In the adult virgin the margins of the opening are usually in contact with each other, closing the aperture in the vagina, more or less completely. The size of the

orifice varies from a pinhead to a caliber which will readily admit the tip of one finger.

The consistency of the hymen is gynecologically important from the standpoint of coitus, dyspareunia, and relative sterility. It may be so firm and rigid that surgical interference may be necessary before coitus can be comfortably accomplished, or it may be very elastic so that no rupture takes place with coitus. Boynton<sup>2</sup> reported a case of pregnancy with an unruptured hymen in an unmarried girl; an Aschheim-Zondek test aided in the differential diagnosis from an ovarian cyst. Contrary to popular lay belief, loss of virginity is not always associated with loss of blood although in very rare instances the loss of blood may be so profuse, as to require surgical treatment.

Cases have been reported in which an almost imperforate hymen had remained intact until labor and ruptured only when distended by the head of the fetus or had to be incised to avoid irregular lacerations. This also obtains in patients having a thick septate hymen, where the bridge of tissue has to be cut before delivery can be accomplished. I saw a case of the latter during my internship days on the Gynecological and Obstetrical Service at the Carney Hospital. Papadopoulos<sup>3</sup> reported a case of ectopic gestation with an apparently imperforate hymen.

## EMBRYOLOGY

The cephalic portions of the Mullerian ducts become the Fallopian tubes and the fused caudal parts of the Mullerian ducts give rise to the uterus and vagina.

\* From the Department of Gynecology, Tufts College Medical School, and the Gynecological and Obstetrical Service of the Carney Hospital.

According to Cunningham<sup>4</sup> the hymen is formed from a little fold which appears at the point where the vaginal portion of the

which normally degenerate to produce a lumen which becomes the vaginal outlet.

The late C. Jeff Miller<sup>6</sup> advanced two other possibilities as to the causation of imperforate hymen, in addition to the one stated which is the most generally accepted, namely: (1) some infection in intrauterine life; and (2) excessive proliferation and coalescence of the area just back of the septum, rather than its failure to regress.

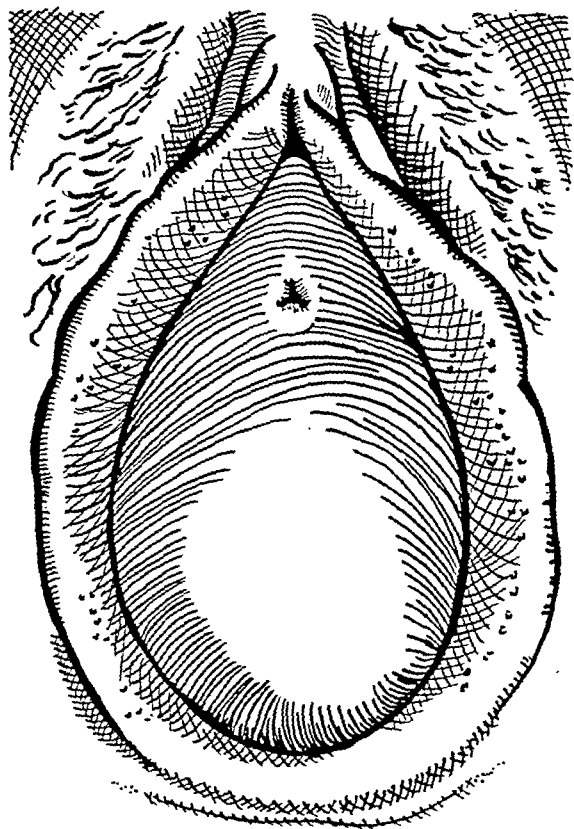


FIG. 1. Imperforate hymen.

fused Mullerian ducts opens into the urogenital canal. He also refers to the direct continuity of the upper surface of the hymen with the vaginal wall and the similarity in structure, concluding that the hymen is a portion of the vagina, from the viewpoint of development.

Williams<sup>5</sup> refers to the embryological researches of Nagel, which have been confirmed by Gellhorn, holding the point of view that the hymen represents the lowest portion of the vagina. He further states: "In early embryos the hymen is composed of a solid mass of epithelial cells and after proliferating rapidly for a time, those most centrally situated begin to degenerate so that a lumen is produced." Imperforate hymen is produced by the persistence of the centrally located epithelial cells of the posterior wall of the urogenital sinus,

which normally degenerate to produce a lumen which becomes the vaginal outlet. The late C. Jeff Miller<sup>6</sup> advanced two other possibilities as to the causation of imperforate hymen, in addition to the one stated which is the most generally accepted, namely: (1) some infection in intrauterine life; and (2) excessive proliferation and coalescence of the area just back of the septum, rather than its failure to regress.

**COURSE**

Imperforate hymen is rarely recognized before puberty because of the absence of symptoms before the onset of the menses. It may be detected before puberty only when other conditions at the vulva direct attention to this region. After puberty the normal outflow of menstrual blood and mucus secretion is obstructed by the atresia and cannot escape from the vagina. This is followed by an accumulation of menstrual fluid above the obstruction producing hematocolpos first; later when the vagina has been completely filled and distended with menstrual blood, the cervix begins to dilate and becomes filled with blood producing hematotrachelos, and when the uterus in turn is filled with blood we have hematometra. The menstrual fluid then forces its way out into the tubes and the peritoneal cavity. Some of the viable endometrial cells<sup>7</sup> which are present in the menstrual flow, may be implanted on the ovary or peritoneum and produce endometriosis. This continued irritation of the menstrual fluid, produces a chemical peritonitis. Adhesions are soon formed which seal the abdominal ends of the tubes. Then with no further avenue of escape, the blood distends the tubes and we have a condition of hematosalpinx.

#### COMPLICATIONS

If not corrected in time serious consequences may follow. The two principal dangers are rupture and infection. Spontaneous rupture may occur externally or internally.

In external rupture the hymen usually gives way. This is sometimes followed by recovery, but more often the distended

toneal cavity. Gerin-Lajoie,<sup>9</sup> reported a case of generalized peritonitis caused by an imperforate hymen.

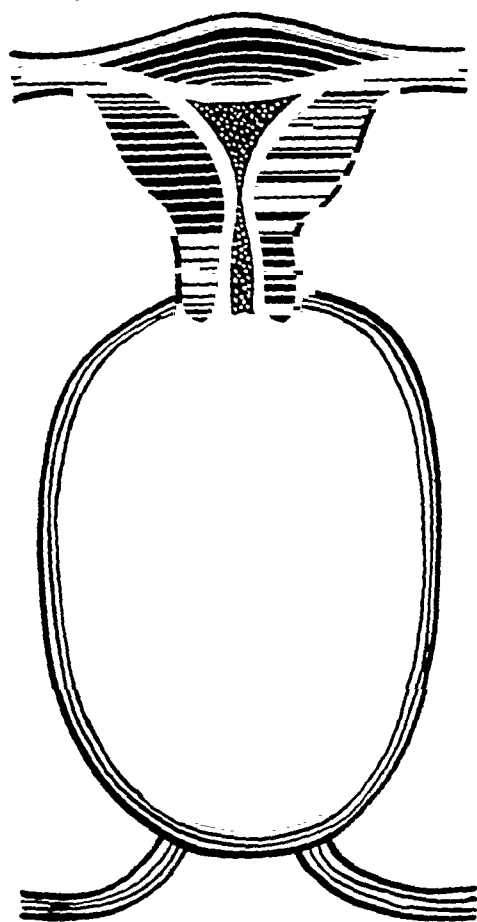


FIG. 2. Imperforate hymen first causes distention of the vagina producing hematocolpos. (After Sulton and Giles.)

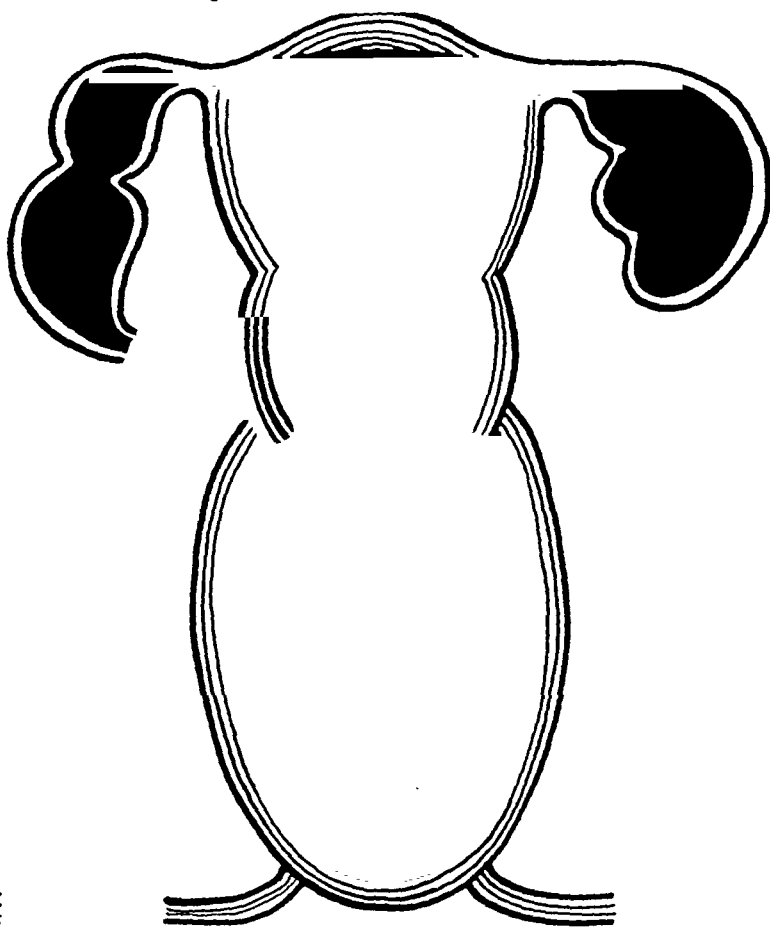


FIG. 3. Imperforate hymen producing in successive stages, hematocolpos, hematotrachelos, hematometra and hematosalpinx. One tube is shown open, while the other shows the abdominal ostium sealed as a result of chemical peritonitis. (After Sulton and Giles.)

cavity becomes infected. Cases have been reported of perforation through the labium majus.<sup>8</sup>

In internal rupture the vaginal, uterine, or tubal walls may be perforated. A vesicovaginal or rectovaginal fistula<sup>8</sup> may be produced and the blood may be discharged through the bladder or rectum. These spontaneous openings are usually inadequate and recurrence of the original condition usually takes place, or a permanent fistula is produced. The most serious complication is an intra-abdominal rupture of hematosalpinx with subsequent peritonitis.

Hematocolpos may become infected by invasion with colon bacilli, producing a retention sepsis which may spread upwards and involve the uterus, tubes and peri-

#### SYMPTOMS

There may be no symptoms complained of by the patient at the onset even when the girl is at the age of puberty, and is menstruating internally. In such a case, obviously the diagnosis cannot be made, unless we are fortunate enough to have the privilege of examining the patient, with the idea of determining whether or not an imperforate hymen is present, as was the case with McIlroy and Ward.<sup>10</sup> They reported 3 cases of imperforate hymen occurring in one family:

The eldest sister, aged twenty years, had never menstruated, and complained of attacks of abdominal pain occurring monthly, for the past six months. She also noticed that her abdomen was increasing in size. Examination

revealed an imperforate hymen with hematocolpos and hematometra. The hymen was excised and she made an uneventful recovery and menstruated normally afterwards.

Exactly one year later, another sister, aged sixteen years, gave an identical history, also of six months duration. Examination revealed a condition similar to that of her sister. Operation was performed with an uneventful convalescence.

The mother then volunteered the information that she has a third daughter who was fourteen years old and had never menstruated, but was symptom-free. The mother was advised to have her daughter come in to be examined. Examination showed an imperforate hymen, but there was no evidence of hematocolpos. An operation was advised and when the hymen was excised two pints of chocolate colored fluid flowed out. Menstruation has been normal since the operation.

Usually however, the patient is at the age of puberty, has menstrual molimen, but does not have an external flow of blood. There is pelvic distress and discomfort, which increases from month to month. Sometimes the pain is very severe and sharp,<sup>11</sup> and is followed by pelvic fullness and pressure, with a general feeling of lassitude. There may be rectal irritation producing a frequent desire for evacuation of the bowels, and vesical irritation producing frequency of urination. Snodgrass,<sup>12</sup> Lazarus,<sup>13</sup> Hammond,<sup>14</sup> and Mouradian<sup>15</sup> report cases of acute urinary retention due to mechanical compression and angulation of the urethra by hematocolpometra. Where acute urinary retention is the presenting symptom in patients at the age of puberty, who have never menstruated, we must not neglect to make a recto-abdominal examination, in spite of the reluctance of the patient, or else the diagnosis will be missed, valuable time will be lost and unnecessary cystoscopic studies and x-ray studies will be made before the correct diagnosis is reached, as happened in one of the cases reported by Lazarus.

#### EXAMINATION

In patients having an imperforate hymen, inspection reveals the lack of hymenal

opening. There may be some bulging and slightly bluish discoloration of the hymenal membrane. Recto-abdominal examination reveals the presence of a soft, fluctuating tumor, which varies in size with the extent and duration of the condition.

Recto-abdominal examination should be performed in every patient at the age of puberty who does not menstruate and who has attacks of abdominal pain. Nelson<sup>1</sup> reported a case in which the abdominal examination suggested an acute surgical condition in the abdomen. A rectal examination was not done. A tentative diagnosis of acute appendicitis was made and at operation hematometra and hematosalpinx were found with dark colored fluid in the abdomen. The hymen was then inspected and found to be imperforated.

#### DIAGNOSIS

The diagnosis is easily made if a careful history is taken and a careful examination is made, including inspection of the hymen and recto-abdominal palpation.

#### TREATMENT

The treatment is surgical. The first principle to bear in mind is rigid asepsis throughout the operative and convalescent stages, because of the danger of infection. Under a general anesthetic a crucial incision is made and the fluid is allowed to escape slowly. Then the central area of the hymen is excised and the cut edges are sutured with fine catgut to control the bleeding. Mere incision, without excision of the central area of the hymen is not enough, as shown by the case reported by Nelson<sup>1</sup> in which the imperforate hymen was merely incised, the fluid allowed to drain out, and a rubber tube drain inserted. Four weeks later the incision in the hymen was closed and another operation had to be performed.

Irrigations are not advised because of the fear of spreading infection upward. If there is evidence of a tubal tumor, a laparotomy should be performed and a radical operation done removing all pathological organs.

The dangers of infection are too real to warrant conservatism in such cases. Drainage should always be instituted because these patients are potentially septic.

#### SUMMARY

Imperforate hymen is clinically important even though the condition is not very common. It is produced by the failure of the centrally located epithelial cells of the posterior wall of the urogenital sinus to degenerate.

When this condition obtains the menstrual blood is prevented from flowing out of the vagina and begins to back up, producing in order, hematocolpos, hematotrachelos, hematometra, hematosalpinx and sometimes endometriosis.

If imperforate hymen is neglected, complications may occur. These are produced either by rupture or infection.

We must think of imperforate hymen when a patient at the age of puberty does not menstruate and complains of pelvic distress, discomfort or pain, which increases in severity from month to month. Acute urinary retention may be the outstanding symptom.

Imperforate hymen is recognized by the lack of a hymenal opening on inspection, and the presence of a soft fluctuating tumor on recto-abdominal palpation. Recto-abdominal examination should not be neglected in these patients.

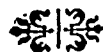
The treatment consists of making a crucial incision to allow the fluid to run out

slowly, and then excising the central area of the hymen and suturing the cut edges.

The literature is reviewed.

#### REFERENCES

1. NELSON, M. S. Congenital atresia of vagina due to imperforate hymen. *Illinois Med. Jour.*, 53: 279-280 (April) 1928.
2. BOYNTON, R. E. Pregnancy with unruptured hymen. *Journal-Lancet*, 54: 646 (Oct. 15) 1934.
3. POPADOPOULOS, B. S. A case of ectopic gestation with an apparently imperforate hymen. *Lancet*, 1: 140 (Jan. 25) 1919.
4. CUNNINGHAM'S Text Book of Anatomy, Ed. 5, edited by A. Robinson, New York, William Wood and Co., 1922.
5. WILLIAMS Text Book of Obstetrics. Ed. 5, New York, D. Appleton and Co., 1924.
6. MILLER, C. JEFF in DAVIS' Gynecology and Obstetrics. Hagerstown, Md., W. F. Prior Co., 1935, Vol. 2, Ch. 8.
7. MCGINN, J. A. and HARER, W. B. Hematometra. *Am. Jour. Obst. and Gynec.*, 30: 704, 1935.
8. STUMDORF, A. Gynoplastic Technology, Ed. 2, Philadelphia, F. A. Davis Co., 1923.
9. GERIN-LAJOIE, L. A case of imperforate hymen, cause of generalized peritonitis. *Union méd. du Canada*, 63: 468-472 (May) 1934.
10. McILLROY, L. and WARD, I. V. Three cases of imperforate hymen occurring in one family. *Proc. Roy. Soc. Med., Sec. Obst. and Gynec.*, 23: 13-14 (March) 1930.
11. DROSIN, L. Imperforate hymen with anomalous anatomical union and position. *Med. Rec.*, 141: 530 (June 5) 1935.
12. SNODGRASS, M. R. Acute urinary retention in female; case due to hematocolpometra. *J. A. M. A.*, 97: 777 (Sept. 12) 1931.
13. LAZARUS, J. A. Acute urinary retention from vaginal occlusion, due to imperforate hymen, 2 cases. *New York State Jour. Med.*, 32: 339-340 (March 15) 1932.
14. HAMMOND, F. C. Imperforate hymen causing retention of urine. *Atlantic Med. Jour.*, 29: 690-691 (July) 1926.
15. MOURADIAN, A. H. Acute urinary retention due to hematocolpometra. *Med. Jour. and Rec.*, 135: 369-370 (April 20) 1932.



# BIOPSY OF UTERINE CERVIX\*

LOUIS E. PHANEUF, M.D., F.A.C.S.

Professor of Gynecology, Tufts College Medical School; Gynecologist and Obstetrician-in-Chief, Carney and Malden Hospitals; Surgeon, Department of Gynecology, New England Medical Center

BOSTON

ACCORDING to statistics, carcinoma of the uterus is said to account for approximately one-third of all malignant neoplasms in women. About 90 per cent of carcinomas of the uterus have their origin in the cervix, while the remaining 10 per cent arise from the endometrium. The uterine cervix has two types of epithelium, cylindrical epithelium, lining the cervical canal and squamous stratified epithelium, covering the vaginal portion. Malignant epithelial new growths of the cervix most frequently develop at the junction of the two epitheliums at the so-called mucocutaneous border. Because of the anatomical configuration of this organ, three main types of epithelial malignant disease may develop in the cervix; a true adenocarcinoma, from the cylindrical epithelium of the endocervix; an adenocanthoma, a tumor composed of glandular and squamous elements, arising in the portio or cervical canal, and a squamous cell or epidermoid carcinoma from the stratified squamous epithelium of the portio. Primary sarcoma of the cervix is extremely rare; I have met it but once in a gynecologic experience of twenty-four years.

Chronic irritation is admittedly an important predisposing factor in the development of malignant disease of the cervix. Infection resulting in chronic inflammation and the trauma of childbirth, with superimposed infection and inflammation, play a conspicuous role in favoring the development of this condition.

The uterine cervix is readily accessible to palpation, inspection and treatment. For these reasons it would seem logical to

expect better results than we are now obtaining if patients presented themselves earlier to their physicians. When the cause of carcinoma is discovered, the treatment may be entirely changed. For the present our strongest arms against the disease are (1) prophylaxis, (2) early diagnosis and (3) early treatment.

## PROPHYLAXIS

If it is rightly assumed that chronic irritation is an important element in the production of malignant disease of the portio, it is logical to feel that the prophylaxis rests in removing all sources of irritation from that organ. There are no symptoms in early carcinoma of the cervix; the symptoms are slight and frequently overlooked in moderately advanced cases. Hence, the basic principle involved rests primarily on the periodic examination of all women during the period of sexual activity or childbearing age. Carcinoma of the cervix is known to occur at all ages, but it is most commonly encountered between the ages of forty and fifty years. After seventy years of age it is uncommon. The periodic examination will lead to the detection of irritative lesions and their eradication. It is worthy of emphasis that no obstetrician should discharge his patient after childbirth until her cervix is completely healed. Simple erosions may be treated in the office by linear cauterization, which may be done in one sitting, or in two or three sessions, and the same form of treatment may be employed for the lesser lacerations of the cervix. In the younger group of women, still in the childbearing age, the extensive lacerations of the cervix with scar tissue and

\* From the Department of Gynecology, Tufts College Medical School, and the Gynecological and Obstetrical Service of the Carney Hospital.

ectropion should be required by trachelorrhaphy. After the menopause, or in women where future pregnancies are not con-

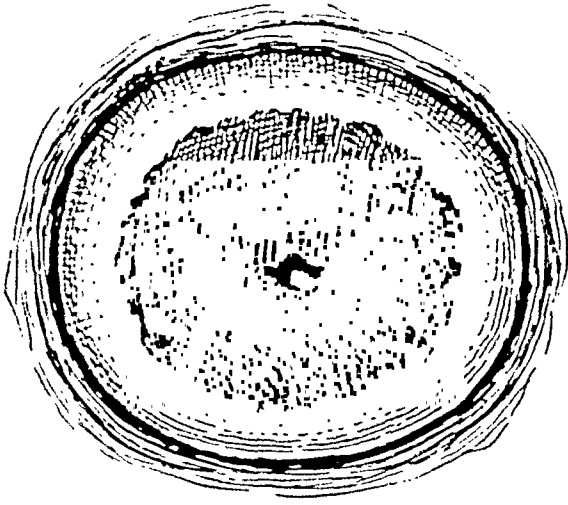


FIG. 1. Extensive erosion of the cervix following infection and inflammation.

sidered the cervix should be amputated, as, is so doing, the organ in which 90 per cent of the carcinomas of the uterus develop is removed. Again, the endocervix and portio vaginalis should be thoroughly cauterized

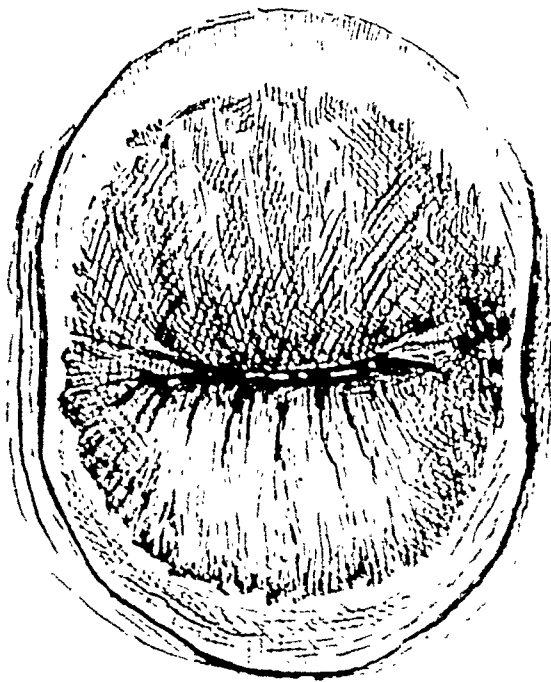


FIG. 2. Deep laceration of the cervix with ectropion. The scar tissue at the edges of the laceration keeps the cervical lips everted.

before the performance of a supravaginal hysterectomy to prevent the occurrence of stump carcinoma.

#### EARLY DIAGNOSIS

*Biopsy.* It is often impossible to differentiate, with the naked eye, between

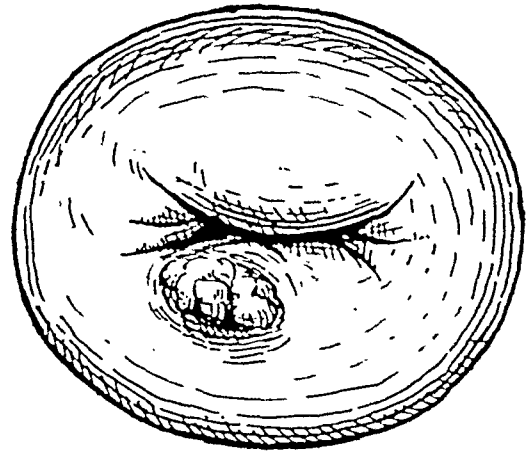


FIG. 3. Early carcinoma of the cervix involving only a small area on the posterior lip.

severe chronic inflammation and early carcinoma. If there is transition from chronic inflammation to carcinoma, in the interest of the patient, this should be ascertained as early as possible. A small lesion limited to the cervix is curable, while one which has extended beyond that organ in the rich lymphatics of the parametria is fatal in a very high percentage of women so afflicted. In order to establish an early diagnosis of carcinoma of the cervix there are three methods available: (1) colposcopy, (2) the Schiller test and (3) biopsy. The colposcope is a magnifying instrument which allows the detection of suspicious areas, patches of leukoplakia, for instance. The Schiller test is carried out by painting the cervix with an excess of Lugol solution; the normal cells take a mahogany brown color, while the carcinomatous, because of their loss of glycogen content, do not take the stain, so that carcinomatous areas appear as whitish spots in a dark mahogany background. Both the colposcope and the Schiller test point out the areas from which a biopsy should be taken. The histological examination of the excised tissue settles the diagnosis.

Three types of biopsy specimen may be obtained from the cervix; (1) from the portio or external surface; (2) from the



endocervix or cervical canal and (3) from a polyp which, under certain circumstances, may become malignant.

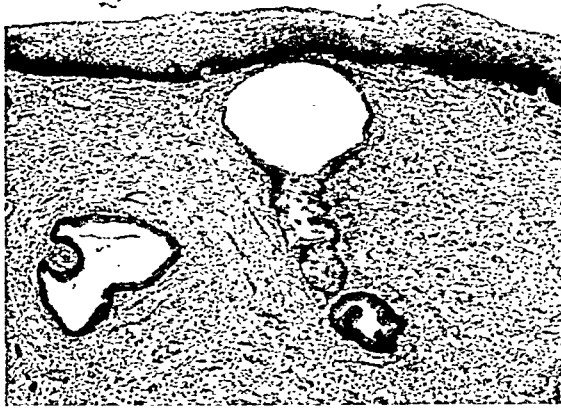


FIG. 4. Chronic endocervicitis, healing cervical erosion (second stage) and Nabothian cyst formation. No evidence of malignancy.  $\times 50$ .



FIG. 5. Cervical polyp showing chronic inflammation, glandular hyperplasia, and epidermization. There is no evidence of malignancy.  $\times 75$ .

#### TECHNIQUE

*Biopsy of Portio.* The cervix is exposed through a bivalve speculum and all secretions are removed from its surface as well as from the vaginal walls. The plug of mucus or mucopus in the cervical canal is dissolved by a weak solution of caroid applied on a cotton-wound applicator. The entire cervix is then painted with a germicidal solution; this may consist of  $3\frac{1}{2}$  per cent tincture of iodine, or of any other preparation which the operator may prefer. *It is a known fact that cutting in a carcinoma of the cervix with a cold knife may rapidly spread the disease to the lymphatics.* The electrically charged wire loop of the high frequency apparatus is the best cutting instrument devised for biopsies of the cervix. It cuts cleanly, does not char the tissues and seals the lymphatics as it cuts through. Anesthesia is usually not necessary for this procedure. In the absence of such an apparatus, a biopsy may be taken with a cold knife provided that an actual cautery is at hand to immediately cauterize the incised area. Light anesthesia may be necessary for this method, which is more traumatizing. In other words, the ideal method of performing a biopsy of the

Bard Parker blade being the best for this purpose, followed by thorough cauterization of the area by the actual cautery. In this day and age, no biopsy of the cervix should be attempted unless facilities for cauterization are at hand.

*Biopsy of Endocervix.* After carrying out the cervical preparation already outlined, a cotton-wound applicator, saturated with a 2 per cent solution of nupercaine, is gently applied in the cervical canal and allowed to remain in situ for twenty minutes. If the cervical canal is not sufficiently patulous, it is gently (not forcibly) dilated with small graduated sounds, so as to allow the introduction of the smallest curette. The surfaces of the cervical canal are lightly gone over and endocervical mucosa obtained.

All the tissue removed at operation on the cervix, repair or amputation, should be considered biopsy material and so treated. A surface biopsy of a suspicious lesion may also be obtained by removing small bits of tissue for microscopic examination, by the sharp cutting clip forceps. Here again it is advantageous to cauterize the area from which the tissue is obtained. In any case, the material removed is placed in 10

per cent formalin solution and sent to the pathologist for examination. The first and last methods may be carried out in the

There are no symptoms in early carcinoma of the cervix. When the classical textbook symptoms appear, the disease is well

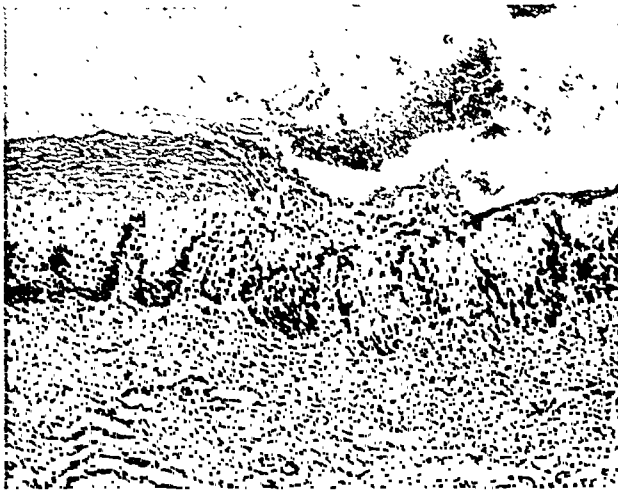


FIG. 6. Atypical epidermoid carcinoma, showing slight differentiation, confined to the surface of the cervix.  $\times 75$ .

office, while it is easier to hospitalize the patient for the second.

#### EARLY TREATMENT

By doing a biopsy on suspicious cervixes, an early diagnosis of carcinoma of the cervix may be established. If the pathological report shows that carcinoma has already begun to develop, treatment by radium and deep x-ray therapy should cure a high percentage of these early cases. If, on the other hand, a report of chronic inflammation is received, the cervix should be cauterized or repaired, as the case may be, in order to prevent the future development of a malignant neoplasm.

Working along these lines at the New England Medical Center, we discovered last year 8 carcinomas of the cervix which could not be detected with the naked eye. These women were all treated by irradiation and their cervixes are completely healed. The lesions were such early ones that the prognosis should be favorable.

I am indebted to Dr. H. Edward MacMahon, Professor of Pathology, Tufts College Medical School, for the photomicrographs illustrating this article.

#### SUMMARY

Carcinoma of the uterus occurs in the cervix in about 90 per cent of the cases.

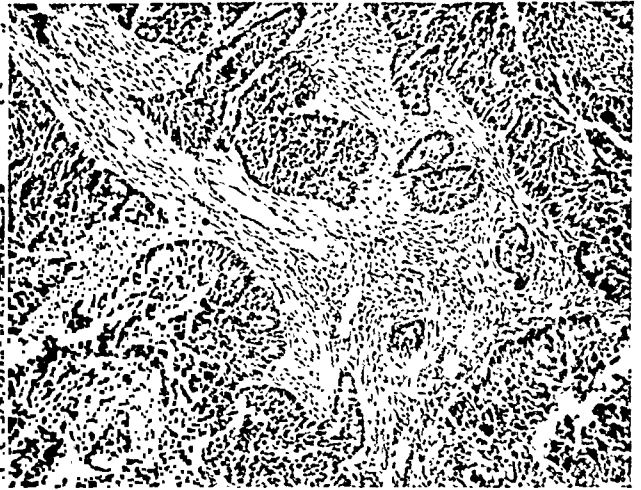


FIG. 7. Adenocarcinoma of the cervix, partly solid and partly glandular, growing with moderate rapidity and invading the lymphatics.  $\times 75$ .

established. In the state of our present knowledge, improvement in the results of

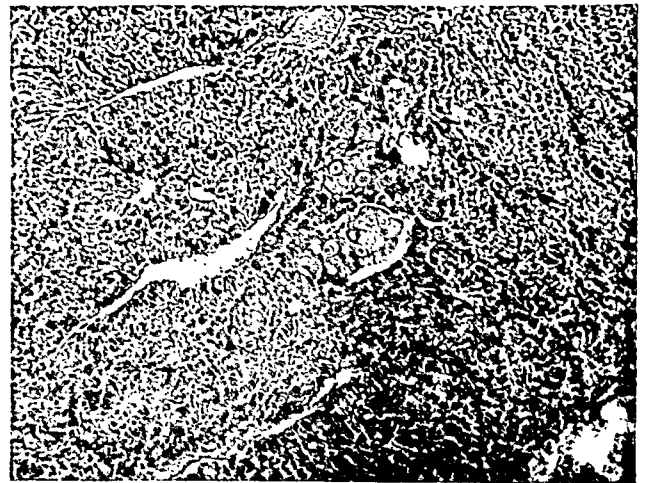


FIG. 8. Adeno-acanthoma (adenocarcinoid-carcinoma) of cervix.  $\times 75$ .

cancer of this organ must come through prophylaxis, early diagnosis and early treatment. Prophylaxis rests on the periodic examination of all women, especially at the time of the menopause, and on the eradication of all irritative lesions of the cervix, such as erosions, polyps, lacerations and infections. It may often be impossible to distinguish between irritative lesions and beginning carcinoma with the naked eye. The early diagnosis must be established

by a biopsy and histological examination of all suspicious areas. The colposcope and the Schiller test point out the regions from which the biopsy should be taken on the portio. The electrically charged wire loop is the best instrument with which to obtain tissue for examination. Gentle dilatation of the cervix and light scraping of the endocervix with the smallest dull curette

will give a specimen from that area. In addition all particles of cervix removed at operation should be considered biopsy material and submitted to the pathologist. Diagnosis of carcinoma of the cervix by means of biopsy, before the appearance of the classical symptoms, followed by immediate treatment, irradiation or surgery, should lead to a high percentage of cures.



# APPLICATION OF RADIUM IN CARCINOMA OF UTERINE CERVIX

A STANDARD COMBINATION FOR CONVENIENCE AND UNIFORMITY

FREDERICK EMIL NEEF, M.D., F.A.C.S.

Director of Gynecology, Misericordia Hospital

NEW YORK CITY

THE surgeon orders radium for carcinoma of the cervix through the hospital office, simply designating "Standard Combination." This includes:

(a) Two, 1 mm. wall thickness, platinum capsules each 25 m.c. w.d. (Working Dose, or actually emitted dose) for intrauterine use. These are supplied, placed in tandem in a thin rubber sac with cord attached. An introducing forceps accompanies this.

(b) Two, 2 mm. wall thickness, platinum capsules each 25 m.c. w.d. (Working Dose, or actually emitted dose) for vaginal use. A piece of ametallic rubber tubing, 3 mm. wall thickness and 8 inches long, together with a dumb-bell joint for fashioning a radium ring of required size to carry the vaginal capsules, are included.

The nurse in charge of the main operating room has a pattern showing how the radon ring is improvised.

In carcinoma of the cervix a dose of about 5500 m.c. hours may usually be given in a single continuous session of seventy-two hours; 100 m.c. w.d. for seventy-two hours equals  $100 \times 55$ , or 5500 m.c. hours.

After a "recovery interval" of eight to fourteen days, a second similar application is made if necessary. Subsequently, the patient receives deep x-ray therapy or telecurie therapy, as indicated.

In this arrangement, it is understood that the physicist calculates the number of millicuries which a capsule of given screen-age (wall thickness) must contain in order to yield the working dose (emitted dose) which the surgeon requests.

In rigid platinum filtration there is a considerable loss of gamma-ray activity on account of absorption by the capsule wall. When the platinum capsule has a

wall thickness of 0.5 mm., the loss by absorption amounts to about  $\frac{1}{20}$  of the dose which the capsule contains; when the capsule wall is 1 mm. thick, the loss is  $\frac{1}{10}$  and when it is 2 mm. thick, the loss amounts to about  $\frac{1}{5}$ .

## RADIUM RULE

To calculate from the Working Dose what is the Total Dosage received:

| Hours Application | Multiply by the Constant |
|-------------------|--------------------------|
| 10                | 10                       |
| 24                | 22                       |
| 48                | 40                       |
| 72                | 55                       |

RADON TABLE

| Working Dose Applied (w.d.), M.c. | Number of Hours | w.d.  | Constant    | Total Dosage, M.c. Hrs. |
|-----------------------------------|-----------------|-------|-------------|-------------------------|
| 100                               | 10              | = 100 | $\times 10$ | = 1000                  |
| 100                               | 24              | = 100 | $\times 22$ | = 2200                  |
| 100                               | 48              | = 100 | $\times 40$ | = 4000                  |
| 100                               | 72              | = 100 | $\times 55$ | = 5500                  |

In preparation, the patient's colon is flushed with warm water on the previous day and the bladder emptied by means of the catheter before operation.

The local growth is traumatized as little as possible; the gamma rays will remove the carcinomatous excrescence.

To keep the uterine and vaginal applicators from dislodging, the vagina is packed with  $1\frac{1}{2}$  inch wide gauze strip saturated with 2 per cent alcoholic mercurochrome solution.

During the irradiation period the patient's position is changed every four to six hours, the dorsal alternating with the right and left lateral postures.

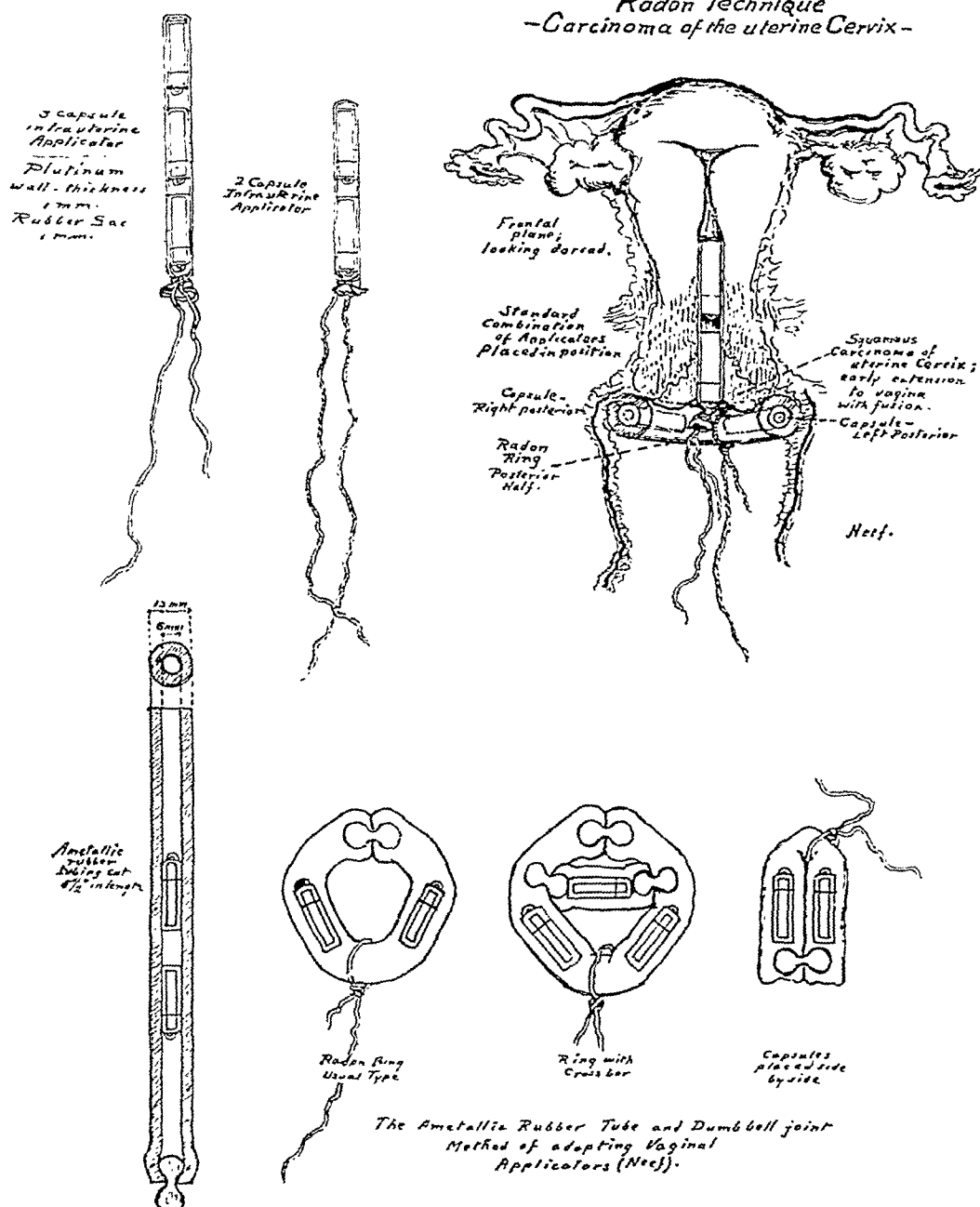
Allonal grains 2.5 and codeine sulphate grain 0.5 are given at 8:00 P.M.

The diet is light and consists largely of fresh fruit.

After removal of the applicators, a warm

implantation of glass radium emanation capillaries. *Arch. Clin. Cancer Research*, 1: 1, 1925; Principles and technique involved in the present day treat-

### Radon Technique —Carcinoma of the uterine Cervix—



saline douche or one with 1 per cent solupinol, or 0.1 per cent lysol is given and subsequently the bowel is flushed by means of a warm water enema.

#### REFERENCES

NEEF, FREDERICK E. The treatment of advanced cancer of the cervix by vaginal and transperitoneal

ment of cancer of the uterine cervix. *Surg. Gynec. Obst.*, 53: 241-249, 1931; A unified plan for keeping records of carcinoma of the uterine cervix. *Am. Jour. Surg.*, 13: 263-269 (Aug.) 1931; Biophysical factors concerned in the clinical course of carcinoma of the uterine cervix. *Am. Jour. Surg.*, 17: 259-269 (Aug.) 1932; The technic of radium-therapy in carcinoma of the uterine cervix. Publicado en el "Libro de Oro," homenaje al Prof. Dr. Angel H. Roffo con motivo de su jubileo de plata con la cancerologia. Las Ciencias, 1935.

# PATHOLOGY AND OFFICE TREATMENT OF CHRONIC ENDOCERVICITIS

HARVEY BURLESON MATTHEWS, M.D., F.A.C.S.

Clinical Professor of Obstetrics and Gynecology, Long Island Medical College; Attending Obstetrician and Gynecologist, Long Island College and Methodist-Episcopal Hospitals; Director, Department of Obstetrics, Coney Island Hospital

BROOKLYN, NEW YORK

IT has been about seventy-five years since Thomas Addis Emmett began his studies on "Erosions of the Cervix." During these many years much has been written by innumerable and diverse authors on all phases of cervical infections, including the far reaching systemic infection resulting from the underlying pelvic pathology. It may be readily conceded, therefore, that it would be extremely difficult, if not impossible at the moment, to bring forth a single new fact regarding chronic endocervicitis. Certainly if such a fact were established it would be front page medical news. On the other hand, medical progress demands, from time to time, the segregation of known facts on a given subject and these, coupled with the correlation of a sufficiently wide clinical experience, are of definite practical value. This is my only excuse for presenting another paper on chronic endocervicitis.

The most important desideratum in the study of chronic endocervicitis is a thorough understanding of the anatomy, physiology, pathology and bacteriology of the cervix and those structures in juxtaposition that are reached by its lymphatic drainage. Pathological anatomy, here as elsewhere in medicine and surgery, must be understood if we are to comprehend the *modus operandi* of disease processes.

In both structure and function the cervical mucosa differs widely from the endometrium of the corpus uteri. The former is composed largely of high columnar epithelium beneath which are deep penetrating racemose glands whose ostia open onto the surface of the endocervical mucous membrane; while the latter is composed of

a stroma with penetrating tubular glands lined with cuboidal epithelium which is constantly passing through the active changes that are essential to menstruation and decidualation. The cervical mucosa therefore is very prone to bacterial infection, particularly the gonococcus; while the endometrium of the corpus uteri is usually immune. Consequently endocervicitis should be a very common pathological lesion, whereas endometritis should be seldom encountered. Pathologic study has proved beyond doubt the truth of this assumption.

The organisms most commonly producing endocervicitis are the gonococcus, staphylococcus, streptococcus and colon bacillus, the gonococcus and staphylococcus being by far the most prevalent. No habitat is more inviting to the gonococcus than the columnar epithelium of the endocervix and the underlying compound racemose glands.

Trauma, as lacerations during childbirth, instrumental dilatation, curettage, inadequate and improper cauterization, conization or surgical diathermy, the constant irritation of a stem pessary, opens up avenues for infection and are therefore predisposing factors in the production of chronic endocervicitis. Trauma, however, is only a contributory cause for it is ordinarily not the extent of the trauma but the incidence and virulency of the infection that produces the underlying pathology.

In children vulvovaginitis from any cause, the exanthemata, especially scarlet fever and diphtheria, and the general debilitating diseases often give rise to chronic endocervicitis. Thus the hematogenous

infections of the cervix cannot be denied. We have ample clinical evidence that, particularly following scarlet fever, acute pelvic infection in the form of salpingitis, ovaritis, and/or endocervicitis occur.

The mucosa of the cervical canal when chronically infected is edematous, swollen and often everted, while the mucosa of the portio about the external os presents a circumscribed area of glandular proliferation. The columnar epithelium covering the mucosa of the cervical canal, under constant stimulation of the infection present, actually "pushes" itself out on to the vaginal aspect of the cervical rim, replacing the stratified epithelium which is normally present in this situation, thus producing the so-called erosion. This erosion or "red area" about the external os, therefore, is not an ulceration, but a new formation of gland tissue and may, under certain conditions, become malignant. There is produced under the stimulation of continued infection, a hypersecretion from the glandular structures. Sooner or later the crypts of these glands become occluded with subsequent formation of cysts (Nabothian cysts). This cystic condition, which may or may not be visible on inspection, increases the bulk of the already hypertrophied cervix and thereby interferes with its circulation and muscular contraction. It is this pathology that is very largely responsible for the premenstrual and postmenstrual metrorrhagia, plus the copious mucopurulent leucorrhea, so constantly observed in chronic cystic endocervicitis. Beyond the confines of the cervix there is always some degree of posterior cellulitis, particularly about the uterosacral ligaments. Likewise, particularly when lacerations are present, there is apt to be some degree of lateral parametritis along the bases of the broad ligaments which may extend along the lymphatic channels for a variable distance.

Microscopically there may be the usual findings of a chronic inflammation. Often, however, there is very little inflammatory changes in the stroma, and, except for a

preponderance of gland tissue, sections appear almost as normal cervical tissue. Section of a Nabothian cyst shows a large sac lined with columnar epithelium filled with clear mucus or mucopus. Surrounding this there is apt to be found a chronic inflammatory zone as evidenced by small round cell infiltration, edema, congestion or dilated lymph spaces, which of course produces more congestion and hypertrophy and this augments the pathological picture.

Infections of the cervix are characterized by a chronicity not characteristically found in other structures of the body, except those in the tonsils, the sinuses and the teeth. In fact, due to its similarity of behavior, the cervix has been aptly called "the tonsil of the vagina." The clinical course therefore is slow and insidious with little or no tendency to spontaneous cure.

The symptoms of chronic cervical inflammation are variable. Leucorrhea is always present; sometimes scanty, oftentimes profuse. In consistency it may vary from clear mucus to mucopurulent to almost pure pus. There may be no other symptom. On the other hand, the symptoms may be many and severe—such as low backache, bearing down sensation in the pelvis, dull aching pain across the lower abdomen extending down into the pelvis, bladder urgency and frequency, with or without pain. General malaise, headache, achy pains in the muscles and joints which may be associated with "stiff" muscles are frequent complaints. Dysmenorrhea, menorrhagia, and, in severe cases with much erosion, metrorrhagia. Dyspareunia is often present. Sterility is a frequent complaint and must be reckoned as one of the sequels of chronic endocervicitis, as evidenced by the frequency with which conception follows its relief or cure.

The prognosis in chronic endocervicitis is doubtful. When the infection is superficial and the concurrent inflammation mild and treatment is instituted early, complete recovery may ensue. On the other hand, when the infection is virulent and the coincident inflammation severe and treat-

ment inadequate, the prognosis progressively becomes more uncertain. Not only does the chronic inflammatory changes in the cervix progress but the associated lesions, as metritis, parametritis and posterior cellulitis, are continuously advancing. Furthermore, chronic cervical inflammation, which means long continued irritation, may be considered a prodrome of cervical cancer, for it is but a step from the extreme cell proliferation with an orderly arrangement that occurs in marked hyperplastic cystic endocervicitis to the disorderly arrangement of embryonal cells found in cancer.

Modern trends in medicine are towards prevention. Education of the doctor, as well as the layman, has brought this idea to the forefront. The old adage "an ounce of prevention is worth a pound of cure" has become the modern vogue.

Gonorrhea is responsible for a very large group of infected cervixes. Prevention in this group has been a big job yielding very poor results. In the future, however, due to the recent renewed activity of all interested groups in the prevention and control of gonorrhea and syphilis, we may expect better results.

In the prevention of another very large group of cervical infections we must begin with the delivery of the child. Good obstetrics reduces to a minimum early and late sequels, thereby lessening disability. The cervix is spared much trauma if full dilatation is obtained before delivery is attempted. It may be "old fashioned" to keep the membranes intact until full cervical dilatation is accomplished but nevertheless the best obstetricians are still "out of step" with the idea of premature rupture of the membranes as a routine procedure. Only on indications do we rupture the membranes before complete or nearly complete dilatation of the cervix. Dry labor is always more exhausting to the mother and likewise more traumatizing to the cervix. Under any condition, when a full term child passes through the cervix, it is lacerated either microscopically or macroscopically,

usually macroscopically. The extent of the laceration, in so far as the infection is concerned, is not of prime importance, for bacteria may enter through microscopic or macroscopic lacerations with equal facility. However, adequate postpartum attention, taking care of cervical lacerations until healing is completed, accomplishes much in minimizing or preventing the entrance of infection, and should be the routine after every delivery. Extensive cervical lacerations, where feasible, should be repaired immediately following delivery.

With all our admonition regarding the prevention of cervical infections, we still have chronic endocervicitis occurring in 60 per cent to 80 per cent of the women seen in private and hospital practice.

Effective treatment of chronic cervical infection is based upon the axiom that "without a correct diagnosis there can be no intelligent treatment." Furthermore a clear understanding of the underlying pathology and the correct employment of the various methods at hand constitute indispensable adjuncts in the proper treatment of chronic endocervicitis. Choose a good method; perfect the technique and success is apt to follow its use. This we have found true in the cauterization method by the use of the small nasal type electric cautery.\*

In order to more clearly outline the treatment by the cautery method, all cases of chronic endocervicitis may be placed in one of the following four groups:

Group 1. The recently lacerated cervix of four to twelve weeks duration of a superficial infection. The nulliparous cervix the seat of a mild gonorrheal or non-specific infection.

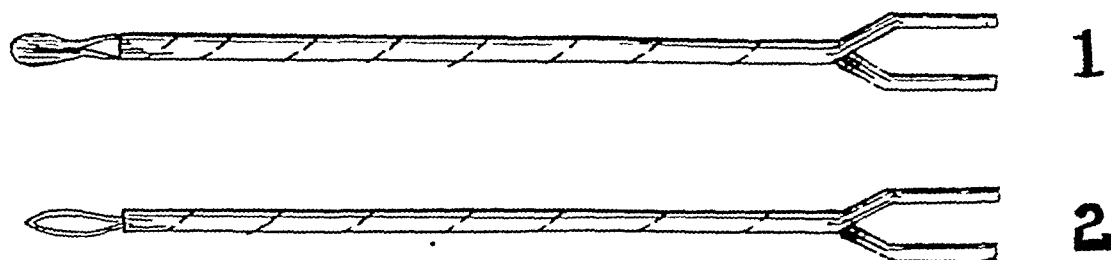
Group 2. The lacerated, eroded cervix of three to twelve months duration with somewhat more and deeper infection than in Group 1 with perhaps a few superficial cysts. This may obtain in a moderately infected nulliparous cervix.

\* Other perfectly satisfactory methods for office treatment of chronic endocervicitis are Hyam's conization, accomplished by a high frequency current and coagulation diathermy.



Group 3. The lacerated, everted, eroded cervix of two to five or more years duration, moderately deeply infected and with or

ing douche (sodium bicarbonate, borax, or sodium chloride, 4 drams to 2 quarts of hot water) once a day followed immediately by



B. HURLEY

FIG. 1. Nasal type of cautery; No. 1, blade tip, generally used for striping or flat cauterization; No. 2, wire loop used for puncturing cysts. It may also be used for striping.

without visible cysts. This is found in the moderately deeply infected nulliparous cervix with or without erosion and cyst formation.

Group 4. The old lacerated, everted, eroded, hypertrophied, cystic cervix deeply and extensively infected and of long duration (from ten to forty or more years). The same condition is found in the extensively infected cystic hypertrophied nulliparous cervix.\*

Such groupings, while more or less arbitrary, simplify treatment. For example, all of the cases in Groups 1 and 2 and the upper half of Group 3 may be successfully treated with the electric cautery. The cases falling in the lower half of Group 3 and all those in Group 4 cannot be successfully treated with the cautery; the Sturmdorf excision of the infected area only or amputation, using a modified Sturmdorf technique, gives excellent results.

The procedure for each group is as follows:

Group 1. Often in this early group we find a retroverted uterus, a few weeks postpartum, that should be corrected. When corrected and held in place with a pessary, involution of both uterus and cervix is stimulated and hence the cervical discharge is lessened. Local application of silver nitrate "stick" or a 20 per cent solution once a week, using an alkaline cleans-

the knee chest position for five to ten minutes, will destroy superficial infections and promote kindly healing of the lacerated tissues. Tincture of iodine 3½ per cent or 4 per cent mercurochrome may be used with success. Far better, however, than any local application, even in the treatment of these very early cervical lesions, is the use of the electric cautery. With the small nasal type cautery using the blade or looped wire (Fig. 1, No. 1 and No. 2) linear striping (incisions) of the lacerated eroded surface is accomplished without pain (Fig. 2, No. 1). The stripings are placed about 1 cm. apart and extend 3 to 5 mm. deep, both lips being striped at the first sitting. In these early Group 1 cases merely cauterizing the erosion with the flat surface of the cautery blade often suffices. Mercurochrome 4 per cent should be painted over the cauterized cervix and a cleansing douche should be taken twenty-four hours later and repeated daily thereafter. Vaginal tampons in this type of office work are never used since we are not convinced of their accredited value. In three to eight weeks there is no sign of erosion. Inversion rather than eversion has taken place. Healing has been accomplished and the cervix is now a normal looking multiparous cervix free of infection and therefore of discharge (Fig. 2, No. 4).

Group 2. In this group the infection has gone deeper in to the cervical tissues, particularly the mucous membrane and

\*The author's grouping in Christopher's Textbook of Surgery, Phila., W. B. Saunders Co., 1936.

glands, hence topical applications are *absolutely useless*. The technique of striping is the same as in Group 1, except that in this

of the cervical canal cannot take place. The pencil type cautery therefore should never be used in this type of work.

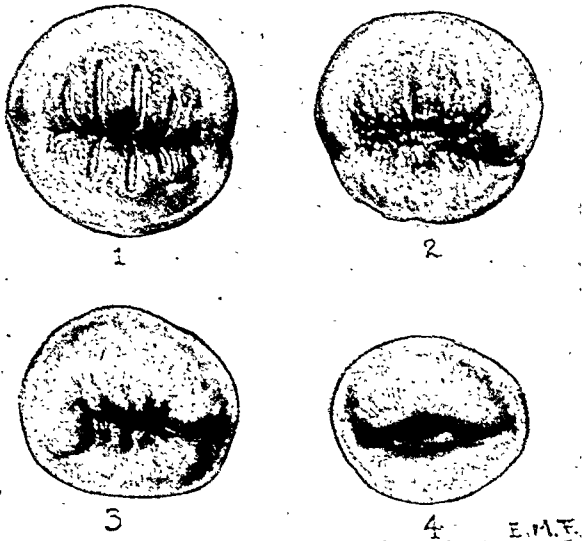


FIG. 2. Method of striping and process of healing. Cervix exposed and held in place by ordinary bivalve speculum. Small fine single tenaculum helps mobilize cervix, but is usually not necessary. Cautery tip (Fig. 1, No. 1.) heated to white heat (never blazing red) before making stripes or puncturing cysts. (Matthews. *Am. Jour. Surg.*, 6: 414-417, 1929.)

group the cauterization must be deeper and more extensive. Begin by cauterizing only one lip at a sitting. The striping must extend from high up in the canal, to or nearly to the internal os, out over and through the everted, eroded area to normal cervicovaginal mucous membrane, 1 to 1.5 cm. apart and 5 to 7 mm. deep (Fig. 3, No. 1). The remaining lip may be cauterized in two weeks. When healing has completely taken place in eight to sixteen weeks we have a fairly normal appearing multiparous cervix with very little if any discharge (Fig. 3, No. 3).

A note of warning should be sounded regarding striping (cauterization) in the canal of the cervix, for if too much of the mucous membrane with its epithelial covering is destroyed epithelialization cannot take place in a normal manner and hence some degree of stricture or stenosis will result. "Islands" of epithelium must be left in situ, otherwise re-epithelialization

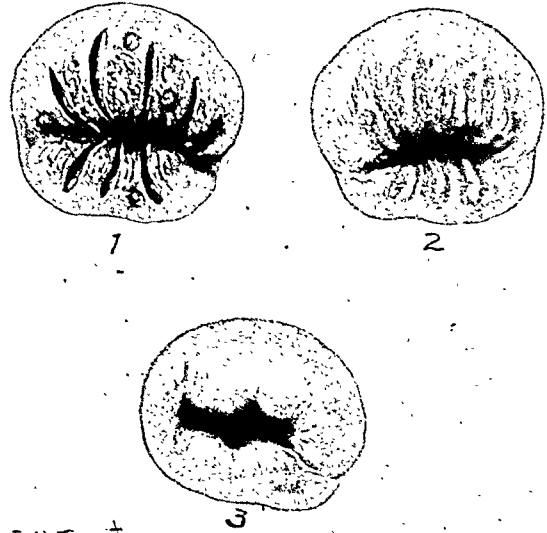


FIG. 3. Similar to Figure 2, except stripings are much deeper and cauterization generally more extensive due to longer standing and deeper seated infection. All visible cysts are punctured after method shown in Figure 4. (Matthews. *Am. Jour. Surg.*, 6: 414-417, 1929.)

Group 3. This is the borderline group. The cautery is not successful in all cases in this group particularly where extensive cyst formation and marked hypertrophy are present. Resort to operation by the Sturmdorf technique or amputation may be necessary. Experience counts for a great deal. Careful, thorough and deep cauterization is called for if success is to follow. For the beginner failure is quite probable. For one experienced in cauterization complete success is certain only for those cases falling in the upper half of this group; while for those in the lower half, with more extensive cyst formation and hypertrophy only partial success or even failure may result. Some form of anesthesia, usually local, may have to be used, particularly for the inexperienced hand that misdirects the hot cautery tip in an already apprehensive patient.

Furthermore there is likely to be some parametrial reaction following this type of cauterization and hence rest in bed for two or three days is in order. A warning

must be given in this connection, viz., never cauterize this group in the presence of acute or subacute inflammation. Marked

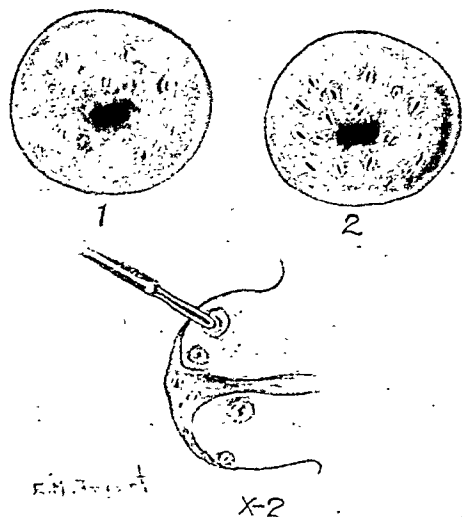


FIG. 4. Method of puncturing cysts. May be used alone or in conjunction with stripings as shown in Figures 2 and 3. This method is applicable to nulliparous cervix, particularly gonorrheal. Note small size of wire cauterity tip. May also be used to destroy latent infection or abscess of Skeene's glands. (Matthews, *Am. Jour. Surg.*, 6: 414-417, 1929.)

local, as well as systemic, reaction is almost sure to follow. In fact in all cauterity work acute and subacute inflammatory lesions in the pelvis are *very strict contraindications* to its use.

Group 4. This is the hopelessly infected cervix of long duration with many cysts and much hypertrophy, that nothing short of the removal of the infected area by the Sturmdorf cone operation or by amputation will relieve the symptoms. The cauterity will not remove the infected area and therefore will not relieve the symptoms, especially the leucorrheal discharge.

The infected nulliparous cervix (gonorrheal or other infection) may be also treated successfully with cauterity. In the earlier stages, after all acute symptoms have subsided, stripings similar to those for Groups 2 and 3 may be carried out. Any cysts may be punctured as illustrated in Figure 4. Early cases properly cauterized give excellent results. Late cases with many deep cysts are not so successfully handled

with the cauterity but are improved, depending upon the thoroughness with which the cauterity is used. Since these cases often come for the relief of sterility as well as for leucorrhea, any form of treatment that will give at least some relief is commendable. Operation on such cervixes, especially amputation is not desirable. In fact *amputation of the cervix during the childbearing age* is absolutely contraindicated, except under very special circumstances.

#### CONCLUSIONS

1. A clear conception of the underlying pathology of chronic endocervicitis is essential for its successful management.

2. Prophylaxis against trauma, laceration and/or infection of the cervix is most important. Likewise the prevention of gonorrheal infection.

3. Efforts directed toward the postpartum healing of all cervical lacerations are paramount.

4. Early recognition and treatment of chronic cervical inflammation gives the best results.

5. The proclivity towards the development of cancer in long continued chronic cystic endocervicitis must be kept constantly in mind; notwithstanding that a few eminent authorities question the truth of this statement.

6. The grouping herein proposed makes for more successful treatment, because the diagnosis of the extent of the infection is more nearly correct. The more extensive and deeper the infection the less successful will be the cauterity treatment.

7. There is a large group of chronic endocervicitis cases in which no form of office treatment will effect a cure. The Sturmdorf operation or amputation of the infected cervix is therefore indicated in these cases (some in Group 3; all in Group 4). Amputation should not, unless imperative, be performed during the childbearing period.

8. The problem is difficult; opinions differ; however, with meticulous care in diagnosis and a skillful technique, success will ordinarily follow the use of the cauterity.

# CERVICAL POLYP\*

ROY J. HEFFERNAN, M.D., F.A.C.S.

BOSTON

**C**ERVICAL polypi are pedunculated growths varying in size from a pea to a walnut. They usually have their origin in the cervical canal and are covered by columnar epithelium. More rarely a solid or fibrous polypus develops from the portio vaginalis.

## PATHOLOGY

The glandular type consists of a loose fibrous stroma, containing one or more blood vessels and covered by columnar epithelium similar to that lining the cervical canal. Small round cell and polymorphonuclear infiltration may usually be noted. Cervical glands may be present. Polypi arising from the vaginal portion of the cervix are covered by squamous epithelium.

## ETIOLOGY

The exact cause is unknown. Polypi usually occur, however, as a late manifestation of endocervical inflammation.

## SYMPTOMS

Spotting, staining, or frank bleeding between the menstrual periods should always make one suspect a cervical polyp. There may be a thick mucilaginous discharge tinged with blood. The showing of blood may follow coitus, douching or straining at stool.

## DIAGNOSIS

This is usually easy. The polyp is felt by the examining finger and the speculum reveals a red pedunculated mass protruding from the external os. Rarely it may be necessary to dilate the cervical canal to expose the polyp.

## TREATMENT

Small polypi with a thin pedicle may be removed in the office by seizing the tumor with forceps and twisting the pedicle until it breaks. The base may then be cauterized with the cautery tip. If this is not available carbolic or nitric acid may be used.

If the polyp is large and arises high in the cervical canal it is better to hospitalize. Under aseptic precautions the cervix is dilated and the polyp twisted off. The cervical canal is then thoroughly curetted with a sharp curette and cauterized. This removes other small polypi which may be developing and attacks the endocervicitis usually present. Rarely the polyp will be so large the pedicle cannot be reached. The tumor is seized with a volsella, the capsule incised and reflected and the mass twisted out of its bed or cut away with a scissors. The collapsed capsule is then twisted to torsion its vessels and the base cut through and cauterized.

Although usually benign, all polypi should be examined microscopically for evidence of malignancy.

\* From the Department of Gynecology, Tufts College Medical School and the Gynecological and Obstetrical Service of the Carney Hospital.



# CONGENITAL ABNORMALITIES OF RECTUM

JEROME MORLEY LYNCH, M.D., F.A.C.S. AND G. JOHNSON HAMILTON, M.D., M.R.C.S.

NEW YORK

THE surgical approach to congenital abnormalities of the rectum has never been clearly defined. Hence the practitioner suddenly meets an emergency with which he is ill prepared to cope. Although these abnormalities are by no means rare, but few are encountered by any one general practitioner. Not infrequently, they occur in districts where an expert opinion is difficult to obtain. Evidences of misguided efforts have often come to our attention, making subsequent attempt at repair extremely difficult. The urethra and the vagina are the organs most generally damaged, and the result is a fistula formation. For this reason we have suggested an approach to the problem which minimizes the risk of any serious complication.

No attempt will be made to explain the embryological factors leading to the various developmental arrests, since the causes are irrelevant. The accompanying diagrams illustrate the more common abnormalities, and should suggest the treatment. Obviously, some of the conditions are readily diagnosed but others necessitate surgical exploration. It is this latter group for which we have devised a technique.

Bearing in mind that the operation must frequently be performed under unfavorable circumstances, often by persons of limited surgical experience, and always upon poor surgical risks, the following procedure is suggested:

1. Inspect the perineum with care.
2. Digitally examine any orifices.
3. Attempt to palpate the perineal body and anal musculature.
4. If the examination gives *little* or no hope of immediate restitution of function, perform a colostomy at once. It is safest to make a median incision, as it permits easy access to all parts of the pelvis and abdomen, can readily be extended up or down,

and is unlikely to result in hernia. The most distal part of the sigmoid which can be conveniently delivered should be chosen, its mesentery pierced by a glass rod, and the abdomen rapidly closed. Time is the essence of the operation, and should not be wasted by any exploratory procedures. Local anesthesia with .05 per cent novocaine is most satisfactory.

The colostomy should not be opened until the general condition of the patient demands it. Experienced operators may vary this procedure by inserting a catheter into the ileum, in the manner of an inverted inkwell and fixing the omentum over it. This provides a safety valve until such time as it is desirable to open the colostomy, when the catheter may be removed.

Technically, the operation is simple because there is always overdevelopment cephalad to the underdeveloped portion of the gut. The mortality is usually low.

5. If the examination gives some promise of immediate cure, a simple operation will offer a speedy solution of the problem.

An incision should be made from a point corresponding to the posterior margin of the anus and extending to the sacrococcygeal joint. Through this opening a finger should be inserted and the lowest position of the bowel determined. There is little immediate risk attached to the operation, and slight chance of any permanent damage to the patient, since no vital structures are encountered.

This procedure would demonstrate that the condition found in Figure 1A is susceptible of immediate cure. The fibrous plug between the anus and the rectum should be excised, the edges approximated, and a large tube introduced.

In this, as in all other surgery, the first great rule is, "Never take an unnecessary

risk." Therefore when in doubt perform a colostomy. Remember;

1. That fistulas can be enlarged and made to serve as an anus until the baby is older.

2. Vulval, vaginal and cloacal openings do not call for emergency operations.

3. Colostomy is indicated when the opening is into the bladder or posterior urethra, because of the danger of ascending infection of the urinary tract.

The following cases show the extremely good results to be expected of plastic operations performed when the patients have attained adolescence.

CASE I. The patient had a condition similar to that depicted in Figure 1E for which an operation was performed under general anesthesia. The bowel was surrounded by an incision which was carried posteriorly to within an inch of the coccyx (Fig. 2). The bowel was dissected free from the vaginal wall in front, and from the surrounding tissue. The posterior incision was deepened to the levator ani muscle. The rectum was dissected free from the labia and vagina (Fig. 2B), the levator was now split and the bowel allowed to drop down through this aperture (Fig. 2C). The muscle was then closed above and below the rectum with interrupted sutures (Fig. 2D). The rectovaginal septum was brought down, and the mucous membrane of the vagina was sutured to the skin edges. The rectum was affixed to the levator ani with interrupted sutures, and the mucous membrane was brought to the skin edge in like manner. The skin above and below the anus was closed with interrupted sutures (Fig. 2E).

The patient made an uneventful recovery and leads a normal life.

CASE II. A girl, aged sixteen years, born with an imperforate anus, had a colostomy performed when she was one day old. No attempt had been made to explore the site of the anus.

An incision was made posteriorly from the anus, the coccyx was removed, and exploration showed the anal canal and the end of the rectum attached to the posterior vaginal wall, with a well marked septum intervening, rather similar to Figure 2. An unsuccessful attempt was made to anastomose the distal end of the

bowel to the anal canal. A second operation showed that the distal end of the large gut was strictured above its dense attachment to the vagina. Accordingly, it was decided to clear the hollow of the sacrum and pack it with gauze. Then the colostomy was completely separated from the abdominal wall and closed. The abdomen was then opened in the midline, the leaves of the pelvic mesocolon were divided, and the gut mobilized. The limbs of the pelvic loop were sutured together and attached to the gauze packing, which on removal from below brought the loop into the hollow of the sacrum and the colostomy site into the region of the anus. Appendicostomy was done through a stab wound, and the other abdominal wounds closed. The colostomy stoma was now opened, and sutured into the partially denuded anal canal.

Convalescence was smooth; the appendicostomy proved superfluous and, in the succeeding year, the girl gained twenty pounds in weight.

CASE III. A young girl, aged fourteen years, had at birth a condition illustrated by Figure 2 with the exception that a small sinus existed between the lower end of the bowel and the anus. It is important to note that despite the small size of this sinus, she was able to defecate through it for fourteen years of normal living. When first seen by us she was suffering from constipation and subacute obstruction. At that time there was vomiting, tenesmus, and frequent passage of blood per rectum, and we were told that this condition had existed for weeks.

On examination, a rather well nourished but anemic and nervous child was seen, with a pot-bellied abdomen and a long, narrow chest, and an acute costal angle. The heart, lungs and kidneys were normal. The abdomen was distended and filled with gas. The large bowel, and the cecum especially, was enormously dilated. Operation was decided upon.

Stage 1. The exploratory procedure recommended in this article was performed. It was discovered that the hind-gut terminated at the peritoneal reflection. At about the second sacral vertebra a fibrous cord ran backward, upward, and forward to the anterior commissure. Below this constriction was a dilatation lined by mucous membrane and having no muscular wall.

Stage 2. A median incision was made. The sigmoid colon was delivered, and both leaves

of the mesentery opened. A gauze bandage was tied about the sigmoid and passed into the cul-de-sac. A sponge forceps was introduced

anal orifice. The leaves of the mesentery were closed, the pelvic floor being reconstituted on a higher level and sloping from behind forwards

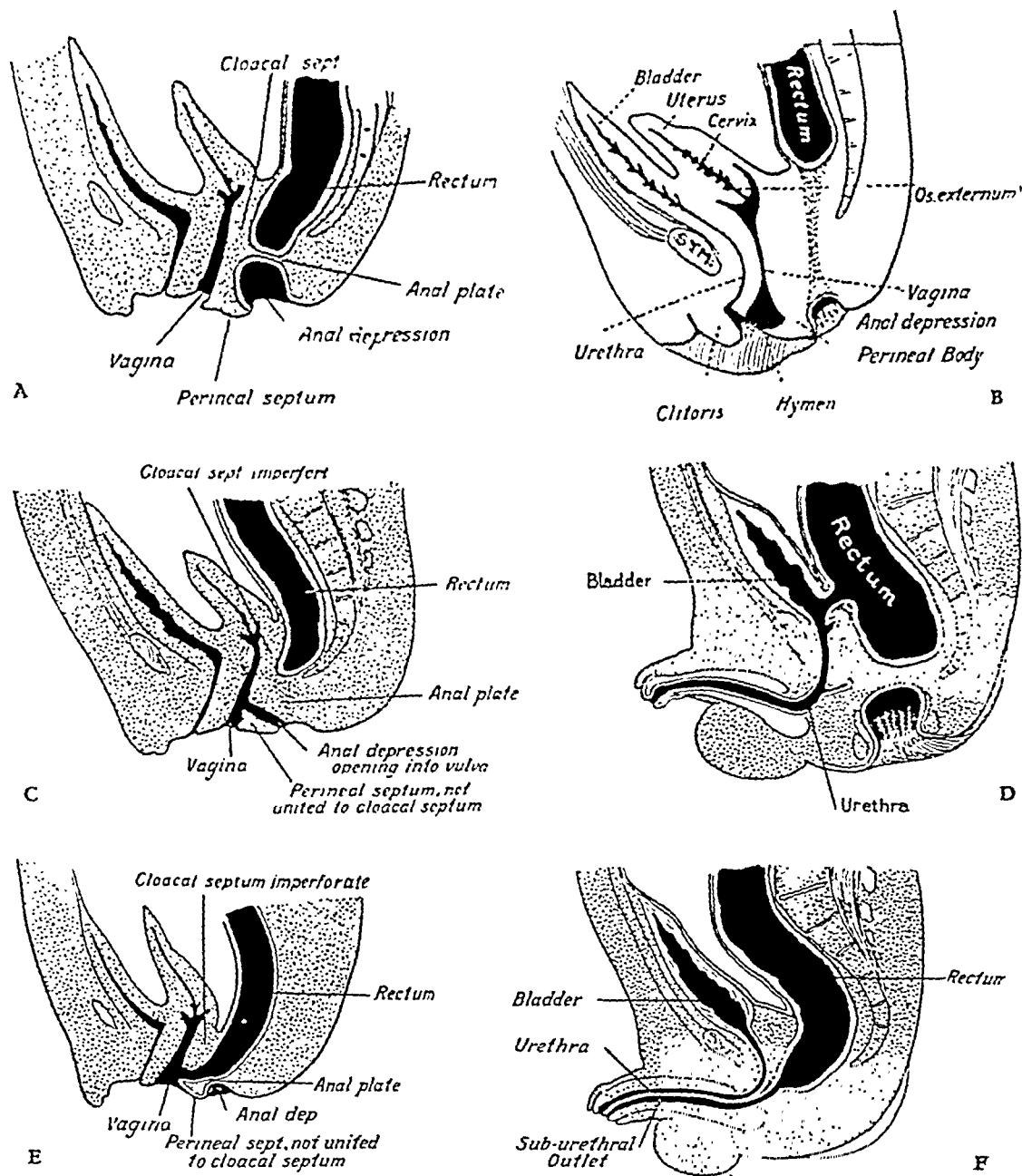


FIG. 1. A, blind hind-gut resulting in a well formed anus ending in a cul-de-sac; B, ending blindly (after Keith); C, anal depression opening into the vulva, perineum or scrotum; D, hind-gut opening into the bladder (after Keith); E, hind-gut opening into vagina (after Keith); F, imperforate anal canal with suburethral outlet (after Keith). (Lynch, J. M. Diseases of Rectum and Colon.)

through the anus and into the cul-de-sac, the gauze was grasped by them, and withdrawn through the anus. Continued traction on the gauze brought the loop of sigmoid through the

and from above downwards. The abdomen was closed in layers.

Stage 3. The prolapsed loop of the sigmoid was then opened, and a rubber tube passed into

each limb, the tubes and the bowel being held in position by interrupted sutures.

Sometime later, the "double-barrelled" per-

2. Some can be corrected at once; others necessitate a plastic operation at a later date.

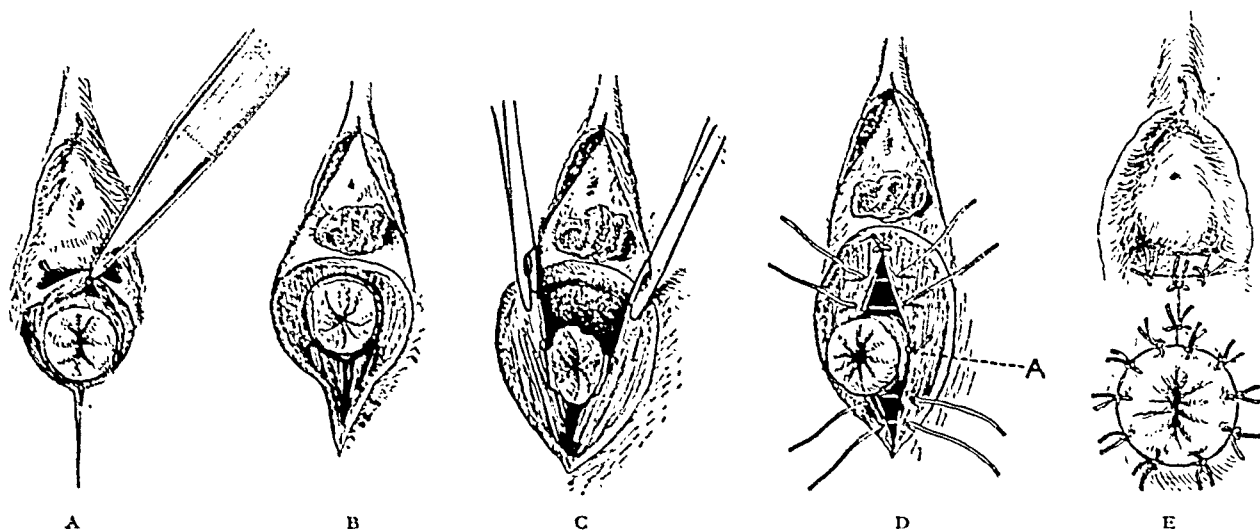


FIG. 2. Cloaca operation (Lynch); A, showing line of incision; B, second stage; C, third stage; D, fourth stage; E, fifth stage, operation completed. (Lynch, J. M. Diseases of Rectum and Colon.)

ineal colostomy was converted into a single one by means of pressure forceps.

#### CONCLUSIONS

1. All malformations of the rectum present an emergency problem in diagnosis.

3. Arrested development is compensated for by overdevelopment cephalad to it.

4. The exploratory procedure suggested in this article is without immediate danger, whereas a haphazard approach makes subsequent repair difficult.





# FISSURE-IN-ANO

EDWARD LEVY, M.D.

Assistant Attending Surgeon, New York Polyclinic Hospital

NEW YORK

**F**ISSURE-IN-ANO is an exquisitely tender and agonizingly painful cleft in the anal canal usually located in the posterior and infrequently in the anterior commissure. It is caused by a diastasis of the conjoined longitudinal muscle and attended with strong spasm of the sphincteric musculature.

Pain, slight loss of blood at stool and constipation are the chief complaints. The pain that may have been a tolerable irritation in the beginning becomes so severe within a week or two that the patient is unable to carry on his usual activities. During or shortly after bowel movement the pain appears and persists for a few minutes to a few hours. Sufferers have described the pain as a "red hot iron in the anal canal"; women regard the pain as more severe than the pains of labor. With each succeeding bowel movement the pain mounts in intensity so that bowel movements are deferred in apprehension of the associated excruciating pains. Pain is usually absent between bowel movements.

Occasionally, pain is referred to the urogenital organs with urinary obstruction, to the back and down the thighs.

An examination to ascertain the condition must be made without alarming the apprehensive sufferer. With the patient in the left Sims position, the nates are slowly spread apart and the patient encouraged to bear down as for stooling. This simple procedure is often sufficient to bring the fissure into view. If this maneuver is unsuccessful, the index finger makes light pressure around the anal margin until tenderness is elicited, the sphincter musculature is gently massaged through the skin, and a digital examination is done with the well lubricated finger making firm pressure away from the tender area. The

spasmodic sphincter yields to the massage and the examining finger can explore the anal canal without hurt to the patient.

On approaching the suspected area, the anal lining should be palpated lightly. The roughened area of the fissure is readily recognized. After the digital examination, a well lubricated anoscope of small diameter can sometimes be inserted into the canal and the lesion visualized. If the patient is too fearful of examination, a local anesthetic (10 c.c. of 0.5 per cent novocain) is injected into the sphincteric musculature subjacent to the fissure. A thorough examination can then be made painlessly.

Table 1 shows the location of the fissure, based on a study of 124 consecutive cases of fissure-in-ano.

TABLE 1

|                           | Male | Female |
|---------------------------|------|--------|
| Posterior commissure..... | 61   | 54     |
| Anterior commissure.....  | 2    | 7      |

The lesion will be found in either commissure, usually the posterior. Early, a sharp linear break which looks like an incised wound, will be seen running from below the crypt margin to the anal verge. The margins and base of the rent are soft and pliable. A probe passed cautiously under the margins often extends freely for a centimeter into the surrounding tissue. With the edges drawn apart, circular bundles of muscle may sometimes be seen as they run at right angles to the tear. In an older lesion a knob of inflamed skin, the so-called sentinel pile, is often present at the inferior end of the fissure and is almost pathognomonic of the lesion. The margins are firmer, the base feels hard, pus is seen exuding from the wound, and the sphincter

spasm is intense. The slight damage found seems at first insufficient to account for the severe symptoms in the history and the spasm encountered in the examination. A close study of the anatomical factors involved is necessary to understand the events that produce fissure-in-ano with its severe pain and strong spasm.

The constancy of fissure at the commissures together with its great frequency at the posterior commissure is due to excessive strain of the anal lining caused by the attached portion of the conjoined longitudinal muscle.

The break in the anal lining occurs in the region between the lower end of the internal sphincter and the upper portion of the subcutaneous sphincter.

Spaces in which divisions of sphincteric musculature are confined, are formed by septa from the conjoined longitudinal muscle which insert into the deep surface of the skin, anal lining and submucosa (Fig. 1). When a break occurs, a space, with its contents of muscle, nerve and blood vessels, is exposed.

Levator musculature (pubococcygei and iliococcygei) through the medium of the conjoined longitudinal muscle, dilate and evert the anal canal during straining or defecation. This action of the levator can be demonstrated clinically during a digital examination. With a finger in the anal canal hooked around the levator musculature, the patient is asked to strain as he would for a bowel movement. The levators are felt to harden and the anal canal to dilate and evert.\* As a result of this dilatation and eversion during defecation or straining, the anal cylinder ends at a higher level than it did during repose. This level corresponds to the area between the internal sphincter and the subcutaneous sphincter, and becomes the rim at the end of the anal cylinder where the breaking action takes place.

The anal lining is exposed to a strain from the distending action of the fecal mass and to the strain of the dilating action

\* The author has called this, "Levy's sign."

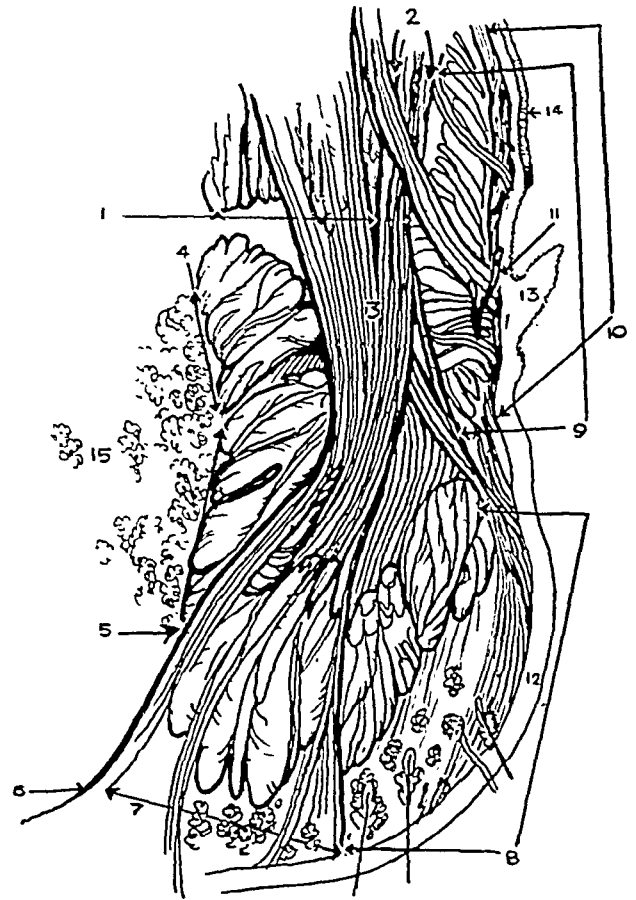


FIG. 1. Schematized longitudinal section of anal canal (Author's modification of Robin and Cadiat).

1, levator musculature {pubococcygeus; 2, longitudinal muscle of gut wall; 3, conjoined longitudinal muscle, name given by author to structure resulting from union of 1 and 2; 4, puborectalis muscle, division of levator muscle that acts as extrinsic muscle of gut wall; 5, profundus sphincter externus ani muscle, division of external sphincter that acts as extrinsic muscle of gut wall; 6, outermost layer of conjoined longitudinal muscle going to back of coccyx; 7, superficialis sphincter externus ani muscle lying in its space between septa of the conjoined longitudinal muscle; 8, subcutaneous sphincter externus ani muscle lying in a space between septa of the conjoined longitudinal muscle; 9, sphincter internus ani muscle divided by septa of the conjoined longitudinal muscle; 10, submucous longitudinal layer of muscle (sustentator mucosae of Rüdinger) with its terminal branches of the superior hemorrhoidal vessels, fusing at its lower end with a septum from the conjoined longitudinal muscle; 11, intramuscular gland; usually six are distributed in the crypt zone. They may penetrate the musculature as much as 2 cm.; 12, skin; 13, anal papilla covered by thin modified skin which extends upward to the end of the mucous membrane. It is in this modified skin above the hairline that fissure-in-ano occurs; 14, mucous membrane of the rectum which ends abruptly below; 15, fat in ischiorectal space. (Author's conceptions of his findings based on his anatomical studies.)

of the levator musculature by way of the conjoined longitudinal muscle. The pressure of the fecal mass within the anal canal

the side wall between the commissures. The posterior commissure fibres differ from those in the anterior commissure in two ways; (1) the longest fibres of the pubococcygei are inserted into the posterior commissure whereas the shortest are inserted into the anterior commissure; and (2) the iliococcygeus on either side sends fibres to the posterior rectal wall where they decussate in the posterior commissure, none going to the anterior commissure. The anal lining is thinnest in the region between the internal and the subcutaneous sphincters.

The factors engaged in the causation of fissure-in-ano are: (1) thin anal lining; (2) both levators in each commissures; (3) in the posterior commissure decussation of the fibres of the iliococcygei and the longest fibres of the pubococcygei; therefore, greatest volume of levator fibres are present in the posterior commissure (Fig. 2).

Contraction of the levators produces the greatest strain in the anal lining of the posterior commissure where the decussating fibres pull away from each other. When the diastatic strain on the anal lining becomes excessive, a break occurs and a fissure-in-ano results. The space corresponding to the involved membrane is exposed; small, torn vessels account for the slight bleeding; and torn nerve endings produce the pain and reflex spasm of the sphincteric musculature—developing a vicious cycle. Should infection occur it is confined within this space by the spasm of the sphincteric musculature which prevents drainage; inflammation of the nerve endings increases the sensory irritation with consequent spasm of the sphincters, which, in turn, further compresses the involved nerve ends, causing increased pain and intensifies the reflex spasm. These nerves derive their origin principally from the third and fourth sacral roots which, in turn, are intimately associated with the roots of the lumbar and dorsolumbar plexuses. From the sacral roots, fibres supply the musculature of the urogenital

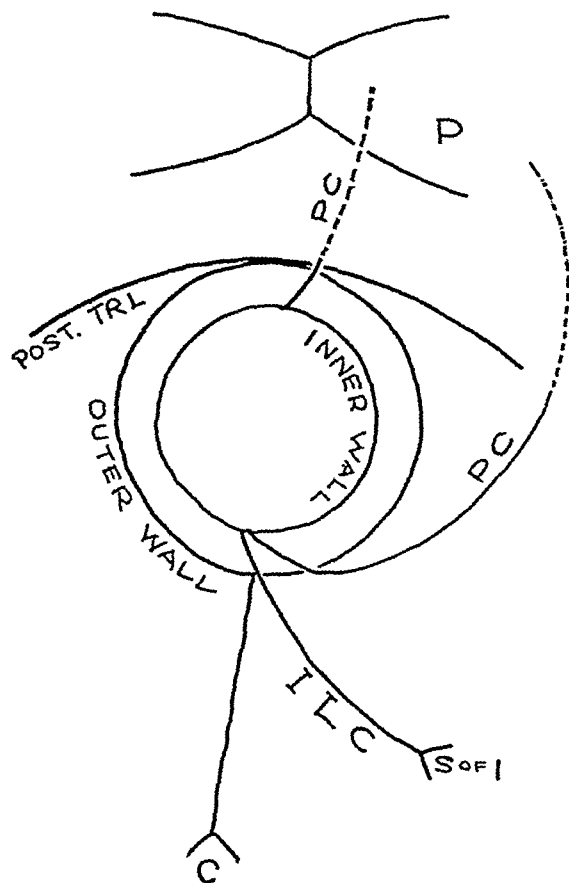


FIG. 2. Diagram of rim at anal outlet during straining with more levator musculature in the posterior commissure as compared to the anterior commissure. P, pubic bone. POST. TRL., posterior border of the triangular ligament. C, coccyx. INNER WALL, anal lining. OUTER WALL, muscle wall of anal canal. P.C., pubococcygeus muscle, with short fibre going to anterior commissure and long fibre to posterior commissure. I.L.C., iliococcygeus muscle. S of I, spine of ischium.

is transmitted equally in all directions so that throughout its circumference, each part of the anal lining suffers an equal strain. The pull of the levator musculature, however, is proportioned unequally because of the uneven distribution of their fibers into the rectal wall. The decussation of the paired levators across the midline in the anterior and posterior commissures produces a strain during their contraction which is almost double that caused by the single levator muscle which is inserted in

perineum and skin, and in this way produce referred pain and spasm anterior to the rectum. Pain in the back and thighs is due

ing tissues or, if the infection remains localized, results in the fibrosis of the affected part, forming a hard unyield-



FIG. 3. Photograph showing nerve supply to the anus. 11, conjoined longitudinal m.; IRS, ischio-rectal space; 1, subcutaneous sphincter externi ani m.; 2, superficial sphincter externi ani m.; 3, profundus sphincter externi ani m.; PU, pudic artery, vein and nerve; HD, inferior hemorrhoidal artery, vein and nerve; HD1, superficial branch; HD2, deep branch; PR, perineal artery, vein and nerve; TUB, tuberosity of ischium; GL. MAX, gluteus maximus m.; CO, coccyx; 4S, fourth sacral nerve; ISC, ischiococcygeus m.; 4S1, superficial branch of fourth sacral nerve; 4S2, deep branch of the fourth sacral nerve. The perineal division of the fourth sacral nerve, 4S, is the principle nerve involved in pain and spasm caused by fissure in the posterior commissure. (Levy, Anorectal Musculature. *Am. Jour. Surg.*, 34: 141-198 (Oct.) 1936.)

NOTE: The I in the illustration should be 1.

to the spread of the sensory disturbance to the lumbar and lumbodorsal roots.

The infection may follow the channels of the inferior hemorrhoidal artery nerve and vein as they run in and through the septa of the conjoined longitudinal muscle and present as an abscess in the neighbor-

ing area in an otherwise resilient elastic canal.

Management of fissure-in-ano is directed toward the control of spasm and infection. In those patients where the margins and base of the fissure are infiltrated, with pus in the space, the treatment is surgical. Such

a procedure should be done in an operating room; its discussion is outside the scope of this paper which is confined to office treatment. The early fissure with soft, pliable base and edges, is a variety of fissure-in-ano which can be treated as an ambulatory case. The treatment is directed against infection and spasm.

To overcome the pain and spasm an oil soluble local anesthetic such as anucaine is employed with gratifying results when the following considerations are observed; (1) ampoule should be warmed before using; (2) a sterilized bone dry 10 c.c. lock syringe with a No. 20 gauge 2 inch needle attached for injection; (3) knowledge of the nerve supply to the part; (4) solution must be deposited in the deep tissues; not a drop should infiltrate the skin.

The skin is prepared by painting with 3½ per cent tincture of iodine. At a point midway between the coccyx and the commissure, the needle is thrust through the skin and when the resistance of the musculature beneath is felt, the injection is begun, distributing 10 c.c. in the midline and for an inch on either side, and a few drops are deposited in the bed of the fissure (Fig. 3).

Within a minute, there is relaxation of the sphincter and the pain disappears. Ichthyol 10 to 20 per cent on a swab is applied to the fissure. The sphincter should be vigorously massaged to prevent the pooling of the injected oil.

The patient should report daily for ichthyol application and digital examination. He is advised to refrain from raw fruits, vegetables and condiments, and encouraged to move his bowels, following

defecation with a hot sitz bath. Mineral oil should be taken freely throughout the course of treatment. At the end of the week if the condition appears to be under control but some spasm is still present, injection of anucaine may be repeated. Treatment usually extends over a period of one month.

Should the pains persist despite this medical attention, then fissure-in-ano must be treated surgically.

Anterior fissures are treated similarly.

#### SUMMARY

1. The pathologic physiology of fissure-in-ano is described.
2. The basis for selection of the type of fissure for ambulatory medical treatment is presented and the treatment outlined.

#### REFERENCES

- ROBIN ET CADIAT. *Journal de Panat*, et de la physiologie, 1874, pp. 589-605.
- TUTTLE. *Diseases of the Anus, Rectum and Pelvic Colon*. Ed. 2, Appleton, 1907. pp. 291-318.
- LYNCH, J. M. *Diseases of the Rectum and Colon*. Phila. Lea and Febiger, 1914, pp. 122-130.
- R. B. GORSCH, M.D. Oil soluble anesthetics in proctology, *Med. Rec.*, pp. 35-38 (Jan. 3) 1934.
- YEOMANS, F. C., GORSCH, R. V., and MATHESHEIMER, J. L. *Tr. Am. Proctol. Soc.*, 1927, pp. 24-32.
- YEOMANS, F. C. *Proctology*. New York, Appleton & Co., 1929, pp. 196-207.
- HILLER, R. I. The anal sphincter and the pathogenesis of anal fissure and fistulas. *Surg., Gynec. and Obst.*, 52: 921-941, 1931.
- GABRIEL, W. B. *Principle of Practice of Rectal Surgery*. London, H. K. Lewis & Co., Ltd., 1932.
- MILLIGAN, E. T. C. and MORGAN, C. NAUNTON. Surgical anatomy of the anal canal with special reference to anorectal fistulas. *Lancet*, 2: 1159-1156, 1213-1217, 1934.
- LEVY, EDWARD. Anorectal musculature. *Am. Jour. Surg.*, 34: 141-198 (Oct.) 1936.
- DANIELS, E. A. Anal fissure, anal spasm, and anal stenosis. *Am. Jour. Digest. Dis. and Nutrition*, 3: 775-783 (Dec.) 1936.



# CRYPTITIS

E. RAPOPORT, M.D.

Instructor, Department of Proctology, New York Polyclinic Medical School and Hospital; Adjunct  
Proctologist, Bronx Hospital

NEW YORK

**C**RYPTITIS is an inflammation of the crypts of Morgagni, variously termed as anal pockets or semilunar valves. It will be remembered that the rectal mucous membrane ends distally in an irregular border, composed of small folds stretched across from the base of one column of Morgagni to another, their concavity being directed upward. They vary in number from five to twelve, and measure in width from 6 to 12 mm. These crypts, whose function is not thoroughly understood, may become clogged with fecal matter, which, because of the shape of the crypt, is not easily expelled. The decomposition of the fecal matter or retained secretion, and the consequent irritation of the crypt starts an inflammation known as cryptitis which, at times, progresses to suppuration. Foreign bodies also may become lodged in crypts. Thus, I have occasionally removed a chicken bone, or a fish bone, seeds and similar objects from diseased crypts, with almost immediate relief of symptoms. Furthermore, frequent, loose and watery stools also give rise to irritation of the anal passage.

## SYMPTOMS

As in most other inflammatory processes, the condition may assume either an acute or chronic form. When the cryptitis is acute, the symptoms are extremely severe, and the tissues involved become very sensitive. Pain is of a sharp and throbbing nature, especially when pus is forming. It is markedly increased on defecation. The anus becomes so tight that instrumentation is almost impossible.

In the chronic form, which is encountered more frequently, the pain is more of a dull and aching character. It is likewise in-

creased during defecation, and is usually worse after exercise and on standing a long time. Next in importance to pain are the attacks of itching near the anus, not relieved by scratching. This results from the hypersecretion of mucus which occurs in the inflamed crypt as well as actual pus, which overflows from it and, as it runs down the mucous membrane of the anal canal, produces an irritation and consequent pruritus.

Furthermore, in aggravated cases accompanied not only by a spasmodic sphincter but also by a contraction of the levator ani muscles, sacrococcygeal neuralgia, constipation, prostatic irritation, frequent micturition and pain in the back and down the legs, are troublesome manifestations.

## DIAGNOSIS

In the acute form, it is perhaps best not to do much examining, either digitally or with instruments. Let the patient take frequent hot sitz baths and apply nupercaine or other sedative ointment, locally for a day or two, until the spasm of the external sphincter relaxes somewhat. Then, to further minimize the discomfort incident to examination, cotton pledgets saturated with a 10 per cent cocaine solution are applied for a few minutes, or better still, the external sphincter is infiltrated posteriorly and somewhat laterally with 0.5 per cent novocaine solution. The perianal skin is now palpated for any areas of induration or tracking, which may lead to the inflamed crypt on the inside of the anal canal. The finger is now gently introduced into the canal and its circumference examined. This will reveal the affected area, in the form of a tender swelling at one side or other of the anal canal.

As a further confirmatory evidence an anal speculum of the removable slide variety is inserted, and the crypt is inves-

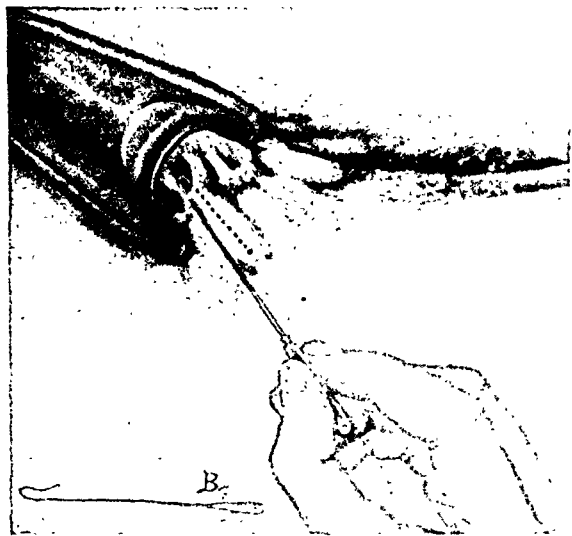


FIG. 1. Exposure of the anal canal through Humphrey's speculum; shepherd's crook probe introduced into cryptic pocket leading down into hypertrophied radial fold. B, shepherd's crook flexible probe. (After Tuttle in Lynch, Diseases of Rectum and Colon.)

tigated by means of a silver probe. This will show whether sinus or fistula formation has complicated the original inflammation. In using the probe, it cannot be overemphasized that one should use the gentlest care, because this manipulation is most painful, and some surgeons even postpone its use until the patient is on the operating table.

#### ASSOCIATED CONDITIONS

Papillitis is associated with cryptitis in about 50 per cent of the cases. This is an inflammation of the papillas, which occur as an irregular line of small, pointed or triangular projections, encircling the junction of the anus with the rectum, called *linea dentata*. They are located at the lower extremity of Morgagni's columns, upon the edges of the crypts.

At times, the chronic inflammatory reaction and decreased elasticity of the tissues, result in a tendency to anal fissures. Proctitis with internal hemorrhoids, or a blind internal fistula, are likewise frequently associated with cryptitis.

#### TREATMENT

Mild cases of cryptitis are sometimes cured by regulating the bowels, by local cleansing, and by making topical applications to the inflamed crypt. Pockets are exposed through a suitable speculum and irrigated with some mild antiseptic solution, after which they are swabbed with ichthyol on a bent probe. This is continued until all the pain has disappeared.

In the more severe cases, however, surgical treatment, which can be carried out in the office, is indicated, since cure is much more rapid and certain, than when palliative measures are employed. The technique is as follows:

The sphincter is anesthetized by local infiltration with 0.5 per cent of novocaine solution and the inflamed crypt is exposed by a Humphrey's duckbill type or a Brinkerhoff, removable slide type, speculum. A bent probe is passed into the crypt and the valve is put at a tension. Then, with scissors curved on the flat the valve is excised, bringing out the incision a little on the skin for the purpose of drainage. After all bleeding is checked a small piece of iodoform gauze is placed on the raw surface.

The postoperative care consists of hot sitz baths of permanganate of potassium solution, 1 to 10,000, twice daily; mineral oil,  $\frac{1}{2}$  ounce morning and evening; the omission of raw vegetables and raw fruit from the diet for about one week; and subsequently, thrice weekly visits to the office, during which topical antiseptic or stimulating applications are made to the raw surface, until it is entirely healed.

In those cases, associated with other definite rectal pathology such as an extensive fistula or a chronic anal fissure with troublesome internal hemorrhoids, the patient is better hospitalized, and the inflamed crypt as well as other pathology properly dealt with surgically.

#### CASE REPORTS

CASE 1. H. K., male, aged forty-three years, presented himself in 1935 for the relief

of rectal pain and pruritus ani, from which he was suffering intermittently for the past six months. The pain was at first of a throbbing nature, later assuming the form of a dull ache. Examination revealed a slightly swollen and inflamed skin tag on the right side at about four o'clock, from which a drop of pus exuded on slight pressure; and by palpating this swelling one could detect a small tract beginning at about one inch posteriorly and extending toward an anal crypt, from which it had apparently originated. The perianal skin was otherwise of normal appearance.

This man was operated on at the office. After the external sphincter and the small fistulous tract were locally infiltrated with 0.5 per cent novocain solution, a small bivalve speculum was inserted into the anal canal. A hooked probe was now introduced into the inflamed crypt and, as it was held somewhat at a stretch, the whole valve was cut away exposing a raw surface. The rest of the fistulous tract was finally dissected out, and a strip of iodoform gauze placed in the anal canal and external wound.

The postoperative care was carried out as described, and the wound was completely healed in three weeks. The pain and itching likewise completely disappeared.

CASE II. Illustrates the necessity for hospitalization. Mrs. M. L., aged thirty-five years, was referred because of complaints of occasional rectal bleeding, pain and protrusion on defecation. Bleeding of bright red blood has occurred periodically for the past four years. The pain began two years ago after the passage of a very hard stool and, always worse in defecation, has progressively increased in severity. The protrusion appeared about one year ago, is reducible, but reappears immediately after straining.

On inspection, a chronic and indurated posterior anal fissure together with a protruding mass, consisting of prolapsed mucosa and anal papilla, was visible. After a local infiltration of 0.5 per cent novocain it was possible to complete the examination digitally

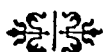
and anoscopically. Very large internal hemorrhoids and elongated anal papillae were then seen at about nine o'clock. At the side of one of the papillae a slightly inflamed area was apparent; this was tested with a hooked probe, and found to be a diseased crypt. In this case hospitalization was advised for the eradication of the whole pathology including the diseased crypt, as revealed by the examination.

#### SUMMARY

1. Cryptitis is an inflammation of the crypts of Morgagni, or anal semilunar valves. It may be acute or chronic.
2. In the acute form, the most important symptom is a constant sharp pain, increased on defecation, and becomes throbbing in character as pus forms. In the chronic forms, this sharp pain changes to a dull ache; attacks of itching also supervene.
3. The diagnosis is made by the history, digital and instrumental examination.
4. Papillitis, fissure-in-ano, internal hemorrhoids, blind internal fistula and proctitis, may be associated with cryptitis.
5. Mild and uncomplicated cases of cryptitis may be satisfactorily treated in the office; when associated with other more important anorectal pathology, it is wiser to perform the whole operation in the hospital.

#### REFERENCES

1. PENNINGTON, J. RAWSON. *A Treatise on the Diseases and Injuries of the Rectum, Anus and Pelvic Colon*. Philadelphia, P. Blakiston's Son and Co., 1923, p. 460.
2. LYNCH, JEROME M. *Diseases of the Rectum and Colon*. Philadelphia, Lea and Febiger, 1914, p. 216.
3. YEOMANS, F. C. *Proctology*, New York, D. Appleton & Co., 1929, p. 257.
4. HIRSCHMAN, J. L. *Handbook of Diseases of the Rectum*. Phila., C. V. Mosby Co., 1926, p. 305.
5. BYLAND, NELS O. Cryptitis. *Tr. Am. Proctol. Soc.*, p. 20, 1931.





# HEMORRHOIDS

C. NAUNTON MORGAN, M.B., (LOND.), F.R.C.S. (ENG.)

Senior Assistant Surgeon to St. Mark's Hospital; Surgeon to the Hospital for Tropical Diseases; Assistant Surgeon and Assistant Director of the Surgical Professorial Unit, St. Bartholomew's Hospital

LONDON

THERE are two distinct anatomical and clinical types of hemorrhoids; internal and external hemorrhoids arising from the internal and external hemorrhoidal plexus respectively.

The internal hemorrhoidal plexus of veins lies under the mucous membrane of the lowest inch of the rectum, and the upper part of the anal canal, above the anal valves. From this plexus, the radicals of the superior and middle hemorrhoidal veins pass upwards and soon perforate the muscle coats of the rectum. Internal hemorrhoids are produced by dilatation of this plexus; low grade inflammation with an increase of fibrous tissue, and an increased blood supply.

The external hemorrhoidal plexus encircles the anal verge and lies under the skin. It communicates with the internal plexus above, by means of straight vessels which run upwards in the columns of Morgagni. These vessels pass through the longitudinal muscle of the anal canal near its insertion.

## CAUSATION

The internal hemorrhoidal plexus is in direct communication with the portal system and since this venous system is devoid of valves, venous back pressure occurs in the lower rectum and anal canal. The erect position of man increases this pressure. Straining at stool, as the result of constipation or diarrhea, leaves the internal hemorrhoidal plexus unsupported by the relaxed sphincter muscles, whilst contraction of the rectal wall above forces more blood into it. The habitual use of aperients, more especially calomel, salts and aloes should be avoided for this reason, and because they undoubtedly produce irritation of the

mucous membrane of the rectum and colon. Prolonged standing, horse riding and straining at work, are factors in the production of piles. Any of the many causes of portal obstruction increase the dilatation of the internal plexus. However, many cases of internal hemorrhoids occur without any definite cause, and further, there is no doubt that there is sometimes an hereditary factor.

As the hemorrhoid increases in size, at first it tends to prolapse through the anus on defecation, returning spontaneously. Later, the prolapse has to be reduced, and finally the internal hemorrhoid remains permanently outside, due to eversion of the lining of the anal canal and stretching of the longitudinal muscle of the rectum and also of the anal sphincters. In advanced cases, the dilatation of the internal plexus is directly continuous with a similar dilatation of the external plexus. This results in a composite hemorrhoid called an intero-external pile. It consists partly of internal hemorrhoid covered by mucosa and partly external hemorrhoid covered by skin. Squamous epithelium may often be seen growing upwards over the red mucous membrane.

## SYMPTOMS

Pain is not a usual symptom of internal hemorrhoids. In early uncomplicated cases, piles lie entirely within the rectum and are composed of comparatively insensitive tissues. Vague discomfort, dull aching or backache may be present.

Bleeding on defecation is by far the commonest complaint. This is slight at first but occasionally may be very severe. A severe degree of secondary anemia may result from the constant steady loss of blood

and a large quantity of blood may accumulate in the rectum with little sign of external bleeding.

grene may follow and in rare instances, infection has spread upwards and fatal portal pyemia has occurred. The perianal

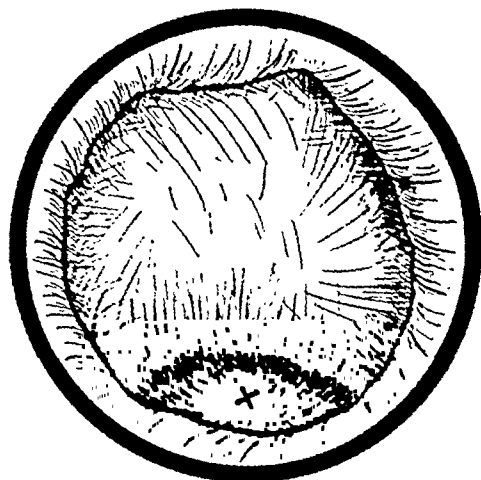


FIG. 1. Anorectal ring appearing in the proctoscope. The x marks the site of injection.

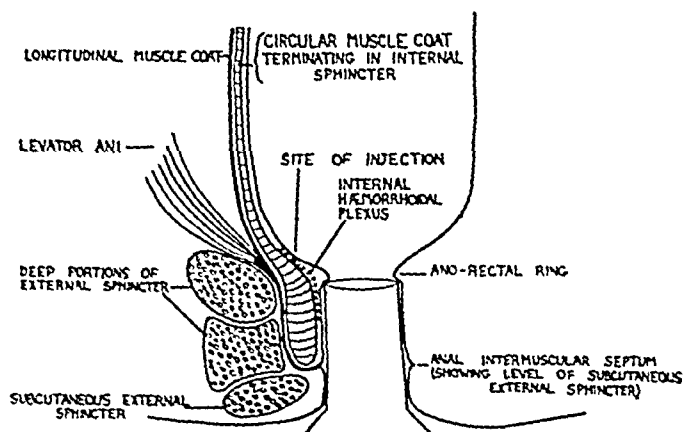


FIG. 2. Sagittal section showing position of proctoscope when the anorectal ring is visible. Note level of subcutaneous external sphincter and position of internal hemorrhoidal plexus.

When the piles reach the first stage of prolapse, the patient usually feels something slip through the anus, and return into the rectum. There may be slight pain at this stage. Finally, when the hemorrhoids remain continually prolapsed, bleeding may occur apart from defecation, due to trauma or engorgement. When prolapsing hemorrhoids have developed gradually, the patient experiences no pain because the sphincter muscles have gradually stretched and accommodated themselves. Should, however, a mass of internal piles prolapse suddenly, pain is severe, due to sphincter spasm, and later to thrombosis and infection. A prolapsed internal hemorrhoid gives rise to a discharge of mucus, and pruritus ani may result. Mental depression is a marked feature of the case, and it is gratifying to observe the remarkable improvement in the patient's mental condition after successful treatment.

#### COMPLICATIONS

When an internal hemorrhoid remains prolapsed it may become congested and thrombosed, due to trauma and infection and the accompanying contraction of the sphincters. Ulceration, infection, and gan-

cuff of skin and the lining of the lowest portion of the anal canal become markedly edematous.

Thrombosed and infected internal hemorrhoids usually resolve and may undergo spontaneous cure, or in the majority of cases, a marked diminution in the size of the piles results. Repeated attacks of thrombosis may give rise to the production of a fibrous polyp.

#### DIAGNOSIS

When pain is a prominent complaint, a careful search should be made for other associated conditions, such as fissure or abscess. Diagnosis is rarely made from the history alone. Unless the hemorrhoids covered by bright red mucosa, are seen prolapsed, it is essential to pass a proctoscope into the rectum to arrive at a diagnosis. The appearance of prolapsed hemorrhoids may be changed by thrombosis, ulceration and infection. Digital examination alone will only reveal the presence of a pile if it is thrombosed, or if there is a marked redundancy of slightly thickened mucous membrane.

When a two inch proctoscope is passed into the rectum and withdrawn slowly, a

prominent muscle ring, the anorectal ring, will be seen closing down immediately above the end of the instrument as it

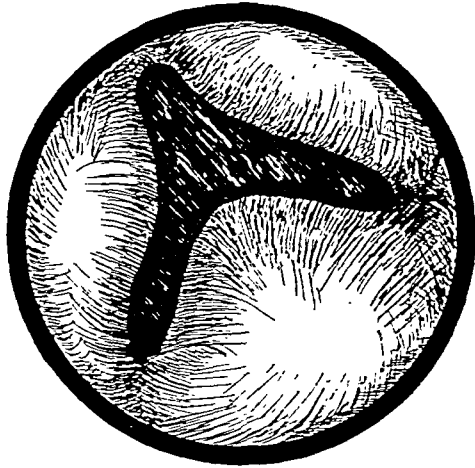


FIG. 3. Proctoscope has been withdrawn further than in Figure 1, and shows internal hemorrhoids producing irregular closure of the anal canal.

passes downwards into the anal canal. As the proctoscope is further withdrawn, this ring contracts down above it in a more or less even manner, like a smooth umbrella ring (Fig. 1). When internal hemorrhoids are present, they bulge into the proctoscope below the level of the upper part of the ring, and the anal canal closes in an irregular manner, somewhat like a camera shutter (Fig. 3).

There are, as a rule, three primary hemorrhoids corresponding to primary divisions of the superior hemorrhoidal artery, situated as described by Miles, at 3, 7, and 11 o'clock (12 o'clock being in the midline anteriorly). The size of the hemorrhoids and the degree of prolapse are better judged when the patient strains gently as the proctoscope is slowly withdrawn. It is important to exclude the presence of other conditions such as carcinoma, epithelioma, fissure, submucous or other types of abscess, fistula, proctitis, papilloma, polypi and hypertrophied anal papilla. The upper part of the rectum should always be examined with the finger and sigmoidoscopy must be carried out before the patient is finally discharged.

#### TREATMENT

There are three methods of treatment with definite indications.

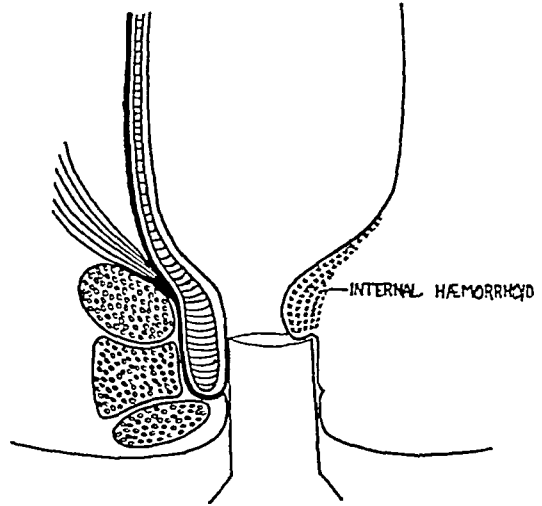


FIG. 4. Sagittal section with the proctoscope in a lower position. Compare this with Figure 2.

1. *Palliative.* Palliative treatment should always be carried out when the hemorrhoids are thrombosed and infected. Not only is it dangerous to inject or operate upon such piles owing to the great risk of spreading the infection, but because, after the "attack" has subsided, either the patient has cured himself, or a few injections at a later date will suffice. For these cases, rest in bed is essential, preferably with the foot of the bed raised. In cases where the prolapse has suddenly come down, reduction into the rectum should be gently carried out, if necessary after the application of an ice pack. Compresses of lotio hydrargyri perch 1-2000 are applied, and frequent hot baths ordered. Mild laxatives, such as confection of senna, milk of magnesia or mineral oil are given.

Palliative treatment is also advisable in very mild cases of internal hemorrhoids, with only slight bleeding, especially if there is rectal dyschezia or congestion of the rectal mucosa.

2. *Injection Treatment.* Though the treatment of hemorrhoids by injection has a very important place in treatment, it is the considered opinion of many authorities that only in certain selected cases does a

cure result, and even in many of these, recurrences are not uncommon. Careful observation in the Out-patient Department of St. Mark's Hospital clearly indicates its limitations. The selection of cases is most important since dangerous complications may occur, or the results be disappointing.

When small uncomplicated hemorrhoids, whose only symptom is bleeding, are present, injection almost always effects a cure. Occasionally, severe hemorrhage is encountered, which at first sight would appear to indicate operative interference, with the necessity of a blood transfusion. Immediate injection of the bleeding hemorrhoids will usually control the hemorrhage at once.

Hemorrhoids which prolapse on defecation or on proctoscopic examination may also be injected. The chemical inflammation resulting from submucous injection high above the piles, fixes the mucosa and by contraction of the fibrous tissue, tends to draw up the hemorrhoid into the rectum. It is impossible in such cases to be sure of the response to the injection, and it is necessary to warn the patient that the prolapse may not be cured.

When the hemorrhoid remains permanently prolapsed, or is of the inter-external type, and also in cases of huge hemorrhoids, injection is not only inadvisable, but is useless. Occasionally, when there is only one hemorrhoid which is continually prolapsed in a patient in whom operation would be undesirable, a high injection above the hemorrhoid may be done. In such a case, it is important to keep the patient recumbent for a few days under observation, because the hemorrhoid might swell considerably and become strangulated by the sphincters. "Local infection is a definite contraindication to injection."

Hemorrhoids, complicated by other conditions, such as fissure, etc., should not be injected until these conditions have been treated.

The method used at St. Mark's Hospital is the submucous injection of 5 per cent

phenol in almond oil, high at the base of the pile.

The knee-elbow position or the inverted (Hanes) position is the most satisfactory, since in this position the rectum becomes distended with air after introduction of the proctoscope and the prominent anorectal ring may be localized.

The correct site for injection is just above this ring because the highest part of the internal hemorrhoidal plexus is situated just above this level (Figs. 1 and 2).

The oily solution is then injected slowly in the submucous layer and the mucous membrane will be seen to be lifted up and become paler. The solution should be injected until a swelling occurs, in which tiny capillaries can be seen on a background paler than normal and slightly coloured yellow by the almond oil. If a dead white area appears during the injection, the needle is lying too near the mucous membrane, and must be withdrawn immediately. Ulceration will occur if the solution is injected too superficially. As the needle is withdrawn some of the solution is injected along its track.

These injections are made at points corresponding with the position of the hemorrhoids, though in actual fact, the solution spreads freely under the mucosa so that the whole circumference of the lumen has been treated.

Usually, 3 to 5 c.c. above each hemorrhoid is necessary, but it depends on the laxity of the mucous membrane. Sometimes, 6 to 8 c.c. must be injected.

On the first occasion, it is wise to give one injection only, since severe reaction, both local and general, may sometimes occur. I have had several patients who have had a mild febrile attack, after injection of the almond oil solution. If the stronger solution containing glycerine (mentioned later) be used instead, then there is no general reaction.

The second injection is given in about ten days. If a good reaction has occurred, the mucous membrane feels leathery both to the palpating finger and to the needle.

When little or no reaction has occurred, the injection is repeated at the same site and in the position of the two other hemorrhoids, but if the mucous membrane is now tough, a smaller injection of 2 to 3 c.c. is given at a slightly lower level through the soft mucous membrane. The patient is again seen in fourteen days, and should there be a good reaction high up, no further injections by this method should be given.

It is sometimes found that though there is a good reaction in the upper part of the pile mass and the submucosa above it, the lower part of the pile may still be prominent. In these cases, one final injection deeply into the centre of each pile, of 20 per cent phenol in equal parts of glycerine and water is given with advantage. Only 3 to 5 minims of the solution are injected at one site. This solution must never be injected high up immediately under the submucosa.

The effect of the injections is very variable; it may be permanent, and in a suitable case the patient should be free of symptoms for one year or more.

3. *Operation.* When operation is necessary, it is undoubtedly a much surer method of curing prolapsing internal hemorrhoids than injection. Though recurrences occur on rare occasions, in most instances the patient is cured or is free from symptoms for twenty years or more.

Though there are many hemorrhoidectomy operations described, it has been found that the modern modification of the simple ligature and excision operation, recommended by Salmon one hundred years ago, gives the most satisfactory results.

It is impossible in this short article to describe in detail the operation. Some of the more important facts only will be given. The rectum and sigmoid colon are emptied by adequate preoperative treatment. The anesthetic used is a low spinal anesthetic, using 25 to 50 mgms. of procaine hydrochloride. This has been found very satisfactory, since it precludes postoperative

vomiting, coughing and straining, which produce edema of the perianal skin.

The left forefinger is inserted into the anus and the anorectal ring felt. With aseptic precautions, 10 c.c. of a solution of local anesthetic in oil of the formula

|                               | Per Cent |
|-------------------------------|----------|
| Procaine base.....            | 1.5      |
| Butyl-para-aminobenzoate..... | 6        |
| Benzyl alcohol.....           | 5        |
| In sterilized almond oil      |          |

are injected through a single puncture  $1\frac{1}{2}$  inches behind the anus in the midline. Five c.c. are injected on either side in a fan-like manner into the external sphincter muscles and finally into the subcutaneous fat around the anus, and also into the ischiorectal fossa. This solution is then gently massaged into the tissues. The anal canal and perianal skin are thoroughly cleaned with weak antiseptics and swabbed with surgical spirit (Figs. 5 and 6).

The sphincters are not dilated but the hemorrhoids are delivered by gently everting the skin at the anal verge with a pair of plain dissecting forceps. The hemorrhoids are seen in turn and each seized with artery forceps. Each pair of forceps in turn is laid in the palm of the hand and gentle traction applied, and the index finger introduced along the forceps into the anus to the level of the upper part of the subcutaneous external sphincter.

If there is no associated external skin tag, a pair of straight blunt ended scissors cuts, at the mucocutaneous junction, towards the tip of the inserted finger. Mucous membrane and submucosa only are left undivided between inserted finger and the end of the scissors. The hemorrhoid has now been dissected free. The hemorrhoid should not be dissected up further than the level of the tip of the finger, otherwise post-operative constriction might occur.

A curved round bodied needle threaded with No. 2 chromic catgut now transfixes the pile at the upper level of the incision and the pile is securely ligatured. The two remaining hemorrhoids are treated in a similar manner. When bleeding has been

controlled, the hemorrhoids are removed, leaving an adequate stump distal to the ligature.

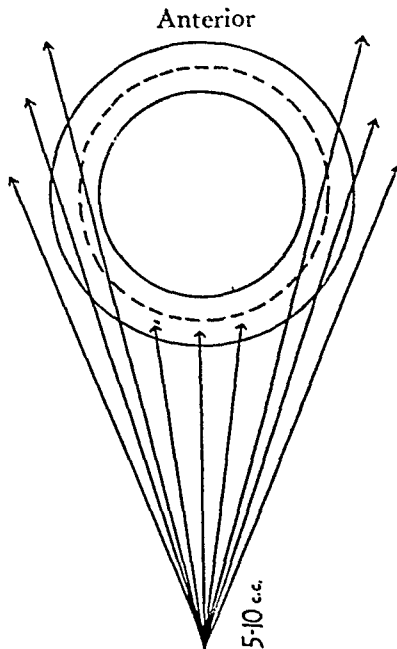


FIG. 5. Method of injection of oily anesthetic solution.

In the case of intero-external hemorrhoids, the external and internal portion of the composite pile are dissected up and removed together.

It is important to remove freely any redundant skin at the anal verge, leaving wounds running radially towards the anus. These raw areas should not be sutured. A small wick of vaseline gauze is finally placed in the anal canal and a firm dressing applied.

Careful preparation, the use of oil soluble anesthetics, and extremely gentle operating, allows this operation to be performed with little or no after-pain.

The bowels are moved on the third day with an olive oil and gruel enema, and daily hot baths instituted. Daily antiseptic moist dressings are applied to the anus.

It is important to pass a finger into the anal canal after the ninth day to anticipate any constriction. This should not occur if the operation is properly performed.

#### EXTERNAL HEMORRHOIDS

External hemorrhoids result from dilatation of the external hemorrhoidal plexus.

As stated, the plexus lies at the anal verge and is covered with skin. This type of hemorrhoid is therefore sensitive.

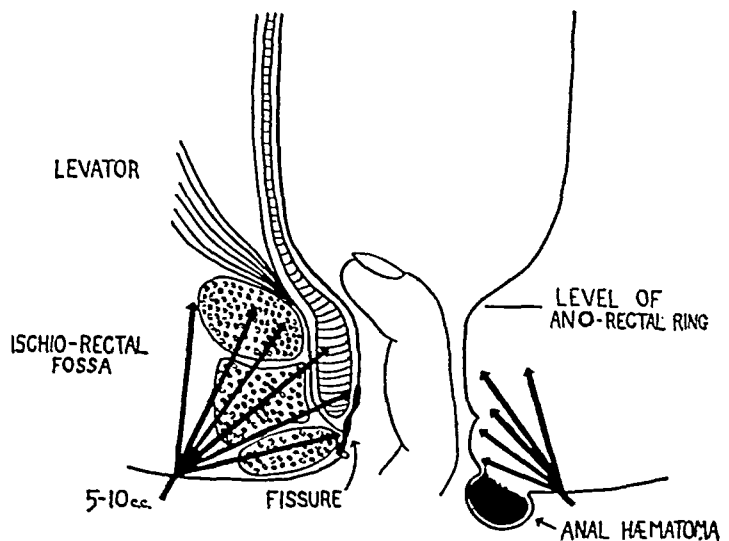


FIG. 6. Showing depth of injection; also the method of infiltration for removal of an anal hematoma.

External hemorrhoids present two main types—

a. Thrombosis of part of the external hemorrhoidal plexus, giving rise to a very painful visible swelling at the anus;

b. Hypertrophied anal skin tags which result either from repeated attacks of thrombosis or from infection in the anal canal or due to trauma from scratching, etc.

External hemorrhoids exist apart from the internal variety but may be associated with them.

*Acute Thrombosed External Hemorrhoid (Anal Hematoma).* As the result of straining either at stool or work or sitting on a cold seat, congestion of the external plexus may occur, resulting in actual rupture of a subcutaneous vein at the anus. Thrombosis occurs and the blood clot may be both under the skin and in the lumen of the vein.

The patient experiences sudden pain at the anus and feels a swelling. On examination, a tense rounded blue swelling is seen under the skin. There may be several thrombotic piles present. The swelling is acutely tender and there may be associated

muscle spasm. Very occasionally, a linear induration from it may be felt passing up in the anal canal. This is due to thrombosis of a connecting vessel lying in a column of Morgagni.

#### TREATMENT

When the swelling is seen soon after its occurrence, it should be excised. This is easily done by infiltrating the subjacent sphincter with an oil soluble anesthetic and removing the skin over the clot. The clot is removed and a search is made for other smaller clots which should also be removed. A small flat wound is left which should be kept clean and dressed daily. The patient has no after pain whatsoever owing to the prolonged action of the anesthetic solution (Fig. 6).

#### HYPERTROPHIED ANAL SKIN TAGS

Fibrous skin tags at the anus may not give rise to any symptoms other than difficulty in keeping this region clean. The skin surface may become abraded and infection, with edema and tenderness, and abscess formation, sometimes results.

#### TREATMENT

These skin tags may be excised in the same manner as the acute thrombotic variety. In old cases, the application of lotions diminishes the swelling.

Liquor Plumbi Subacetatis fort..... 1 drachm.  
Cow's Milk..... 7 drachms.

Lotio Plumbi cum Opio..... 4 parts.  
Surgical Spirit..... 1 part.

It is important to remember that other cutaneous conditions occur at the anus. These include perianal warts, condylomata, primary chancre and epithelioma. Furthermore, an edematous skin tag may be due to a fissure or an inflamed crypt.

#### SUMMARY

A short practical account is given of—

1. The clinical types of hemorrhoids; their causation, symptoms, and methods of treatment.
2. The technique of injection treatment is described and illustrated.
3. The ligature and excision operation and the injection of oil soluble anesthetics are presented.



# INJECTION TREATMENT OF INTERNAL HEMORRHOIDS

VINCENT HURLEY, M.D., F.R.C.S. (ENGL.)

NEW YORK

THE injection treatment of hemorrhoids is an office procedure depending for its success on the exact placing of suitable amounts of well tested sclerosing solutions. The injection must be submucous and above or proximal to the mucocutaneous junction. Proctoscopic examination, if possible to 25 cms., must precede treatment, and of course a summary physical examination is advisable.

## HISTORICAL

One hundred years ago Long, in England, injected ferric chloride directly into nevi to produce sclerosis. Thirty years later Morgan, in Dublin, applied the method and the solution to piles. Shortly afterwards another Dublin surgeon, Abraham Colles, whose name is given to the well known fracture, used ferric chloride in treating a case of hemorrhoids by injection. In the United States, Mitchell of Clinton, Illinois, in some manner hit on the use of a solution containing 33 per cent phenol in olive oil. Subsequently, he is said to have sold his secret to any person able to pay his price and thus loosed a plague of itinerant "pile doctors" who wandered all over the North American continent using phenol solutions varying up to 95 per cent in strength. Andrews of Chicago, a surgeon of repute, got hold of Mitchell's secret and collected and published the results in over 3000 cases.

Naturally enough, considering the exponents of the remedy, some of the accidents were blood curdling. But the secret was out and in the hands of the medical profession, with the usual result. The hasty and inexpert quickly dropped the method with loud and harsh criticism; the more patient continued, and gradually two schools arose over a period of years. Both

schools favored the method, but differed on a point of technique. Briefly, the "strong" group used solutions above 20 per cent phenol, in small amounts, with the aim in view to cause sloughing of the piles, while the "weak" or sclerosing group used solutions of between 5 and 20 per cent phenol, and aimed to produce sclerosis. It is interesting to note that the descendants or successors of the opponents of injection treatment are still with us, while the advocates of injection have become more numerous. The method has undergone many modifications, but it may be said to have become fairly standardized. The "strong" sloughing method has become almost obsolete, leaving the field to the exponents of the sclerosing method who used phenol or quinine and urea in 5 per cent solution.

## PATHOLOGY

Following injection, as shown by microscopic sections, there occurs an aseptic inflammatory reaction, which is followed at the end of five or six days by intravascular clotting and the gradual supervention of fibrosis.

## INDICATIONS

For the beginner, it is wise to limit this method to uncomplicated internal hemorrhoids, and best of all, to cases of simple bleeding without prolapse. In the hands of the experienced, injection of suitable sclerosing solutions may be done where there is considerable prolapse with or without bleeding. Fissure and fistula must be considered as contraindications, and it is well to remember that large external tags complicating internal hemorrhoids will usually prevent a really satisfactory result being obtained by injection.



## EQUIPMENT

Any ordinary firm table will do, as the treatment can be carried out in the knee-chest or lateral positions, though with greater facility in the Hanes position. A good light is essential, and may proceed from a head lamp, a floor lamp, or a small light attached to the speculum.

There is a large assortment of specula from which to choose. In a general way, it may be said that the occasional operator would do better with a set of one type, while the specialist will, of course, recognize the need for a greater variety of types, sizes and lengths. It is my opinion that the beginner would do well to confine himself to a Kelly speculum of medium length and size.

In the matter of the needle to be used, many types have been introduced, the main feature of which is a short, sharp tip set in a stout shaft so that penetration beyond a certain depth is difficult. With the same end in view, other needles have a knob near the point. This type of special needle is really a crutch for poor technique. It is more important for the operator to repair his technical defects than to expect a needle to save him from error. Properly used, a plain spinal puncture needle is adequate. It should be mounted on a syringe of at least 5 c.c. capacity, with a lock joint and fitted with finger grips or rings. The bevel of the needle point is of little importance, though sharpness is desirable.

Of the many solutions which have been introduced since Morgan first used ferric sulphate, two are in common use and give eminent satisfaction. Quinine and urea in 5 per cent solution has been used extensively and with satisfaction, notably by Terrell. Phenol in oil is a much older preparation and has had a world wide test. In proper dilution, 5 per cent in almond oil, it is a very satisfactory preparation, will stand for a long period without deterioration, and when expertly employed is practically free from complications. Occa-

sionally a 10 per cent phenol solution will be found necessary in resistant or recurring cases.

## TECHNIQUE

The old method of injecting piles was to produce prolapse by an enema or previously administered cathartic. Each pile was then injected with a drop or two of "strong" solution, the piles reduced, and the patient dismissed. In many cases this gave excellent results.

In the modern method, no disturbance of the gastrointestinal tract is created. There is no preparation of patient, rectum or anal canal other than verbal assurance that the treatment is not associated with pain. The patient is placed in a suitable position, digital examination is done, and any prolapsing piles are replaced. A speculum, as small as is consistent with adequate visualization, is introduced, and the hemorrhoids inspected. If it is apparent that bleeding has been occurring from any one of the hemorrhoids, that one is selected for injection. The end of the speculum is so manipulated that a fold of pile is raised up at its proximal (anatomically) end, and the needle is introduced into the raised loose part so that the point lies under the mucosa. The phenol solution is now injected without producing any blanching of the mucosa and the upper end of the pile can be seen to swell. When a network of vessels, or the "striation sign," can be clearly seen on the swollen area, enough has been injected. The exact amount of phenol solution injected is not of vast importance, though the operator should read off for his record the amount used in order to gain an idea of what may be required for the average pile in the average case. The needle is withdrawn, the speculum is removed, and the patient is told that he may anticipate no trouble, but that if the piles have previously prolapsed they may rarely do so following the injection, and in such event he should return them without delay.

In a few days another pile may be similarly injected, and so on at intervals until each pile is the site of a definite induration. Injections are now suspended; the patient is symptomless, indeed, bleeding and prolapse usually cease after the first injection, and he is requested to report for observation from time to time, or if there is any recurrence of bleeding or prolapse.

There are many methods of phenol technique other than the above, and good results are obtained by those skilled in them. One favorite method is the injection of the hemorrhoidal ring by using 2 c.c. of phenol 5 per cent in each of the four quadrants at one sitting, and the subsequent placing of suitable amounts as indicated. Quinine and urea in 5 per cent solution may be used in general in a manner similar to the use of phenol, except that smaller amounts are used, 0.5 to 2 c.c. being generally sufficient to cause adequate sclerosis at each point of injection.

#### COMPLICATIONS

Sloughing is the result of too strong solutions or of intramucosal injection. If blanching of the mucosa occurs around the needle, injection should be stopped immediately at this point, as the wrong level is being used and a slough is practically inevitable. Emphasis must be laid on the necessity of placing the sclerosing solution in the submucosa, and nowhere else.

Hemorrhage only occurs following a slough. Abscess has been reported, but has not occurred in my experience. It is prob-

ably due to technical defects. Prolapse following injection has been emphasized by previous writers, and though unacquainted with the condition I have always advised about its possibility when dealing with a patient at the first injection.

General sepsis and pyelephlebitis have been described, but are not found in the reports of any modern expert.

#### CONCLUSION

The treatment of internal hemorrhoids by injection was introduced about seventy years ago, and has been widely applied. After a period of trial, and in this country exploitation by quacks, it has survived and has become fairly standardized. Many slight differences of technique are found today, but in general, dilute solutions are used and injections are spaced out. Symptomatic relief occurs immediately, and the recurrence rate is in the neighborhood of 10 per cent.

The method is far from a fool proof cure, but it can fairly be offered as an office substitute and a time and expense saving method for those unable or unwilling to accept surgery for uncomplicated bleeding or prolapsing hemorrhoids. The method is exacting on the operator, but when properly done is easy on the patient, and in its results in suitable cases is almost equivalent to surgery. Further, relapse can be easily treated, and in my experience patients show no unwillingness to have an occasional "repeat" injection.



# PRURITUS ANI\*

## REVIEW OF 131 CASES FOLLOWED OVER AN EIGHT YEAR PERIOD

MAX P. COWETT, M.D.

Instructor, New York University College of Medicine; Assistant Physician, Bellevue Hospital; Assisting Visiting Physician, Department of Proctology, New York Polyclinic Hospital; Chief in Proctology, St. John's Hospital, Yonkers

### NEW YORK CITY

THAT anal pruritis is a condition which at times baffles the general practitioner, the proctologist and the dermatologist is due chiefly to the following circumstances: (1) it is a symptom to which the doctor gives "too little thought and the patient too much"; (2) in its early stages, anal pruritus is ignored and relief is sought only when it has become chronic and after much physical and mental torment; and (3) the physician often makes a blind diagnosis without a thorough and careful history and a general and rectal examination. The latter is the first essential of treatment.

The 131 subjects reported in this paper were those whose presenting complaint was anal pruritus. A large group of patients who also complained of an "itch" or irritation about the anus, but whose chief complaint was pain or rectal bleeding, are not included in this study. As noted in Table 1 there is a marked preponderance of males over females and also that pruritus ani is a relatively rare condition in the colored race, in spite of the fact that about 8 per cent of our clinic patients are colored.

TABLE 1

| Sex         | Number | Per Cent | Per Cent Clinic Patients |
|-------------|--------|----------|--------------------------|
| Male.....   | 109    | 83.2     | 67.2                     |
| Female..... | 22     | 16.8     | 32.8                     |

Pruritus ani is a symptom and not a disease. It should not be considered as a diagnosis, but, like rectal pain or hemorrhage, a symptom of some underlying

cause. Various classifications have been made of pruritus but to me the simplest one is that based on etiology.

1. Pruritus may be caused by or may be accompanied by every known rectal disease, such as carcinoma, colitis, polyps, hypertrophied papillas, hemorrhoids, fissure, fistulas.

2. It may be a manifestation of a general or constitutional disease, such as diabetes, nephritis, uric acidosis, malaria, tuberculosis, liver disease and the menopause.

3. Itching may be due to irritation from clothing; as dyed underwear or tight clothing. Under this heading might be included personal uncleanness and excessive sweating.

4. Pruritus ani may be a reflex from diseases of the bladder, prostate, uterus, ovaries or vagina—vesiculitis, cystitis, trigonitis. In women one finds frequently a pruritus ani resulting from a profuse vaginal discharge. In the patients, if a rectal examination is negative, the treatment of the pruritus will be that of the gynecological condition.

5. Many skin diseases may recur around the anus, such as eczema, herpes and lichen simplex.

6. Parasites such as pediculi, ringworm and threadworm (*Oxyuris vermicularis*) may cause pruritus ani.

7. Pruritus ani may be on a dietary or allergic basis; strawberries, seafood, spices, alcohol and tobacco are frequent offenders.

8. Rectal constipation is probably the most common cause of anal pruritus, and one that is frequently overlooked or not considered. In this series of 131 cases whose

\* From the Proctology Clinic of Dr. J. M. Lynch, New York Polyclinic Medical School.

chief complaint was itch, on digital and anoscopic examination, 114 revealed that the ampulla was either filled or partially filled with feces. Rectal retention was demonstrated in spite of the fact that the majority of these patients gave no history of constipation. It is our belief that many of these so-called idiopathic cases previously mentioned in the literature properly fall into this group. In these patients much can be done by early treatment with the simplest measures, especially before the condition becomes chronic and the skin changes become marked.

Much has been written concerning the role of bacteria in the cause of pruritus. Dwight Murray considered the streptococcus fecalis to be the infection organism; Others have ascribed the colon group as a causative agent in the pruritides. While no bacteriological research has been done at our clinic, the author believes that the majority of workers in proctology and bacteriology do not concur in this thought.

In many instances of pruritis ani of long standing, there is no doubt but that a "vicious cycle" is established. The pruritus, originally being due to some simple cause as excessive sweating or rectal constipation, starts insidiously, the scratching, however, causes the skin changes and increases the severity of the dermatitis.

Characteristic appearance of the skin around the anus shows it to be thrown into numerous deep folds radiating from the anal orifice. If moisture is present, the skin is white, soggy and macerated, with scattered small areas where the skin has been denuded of epithelium by scratching. In some cases the skin is dry and scaly, in others there are cracks or furrows which extend up to the anal mucous membrane. In stout individuals a real fissure may extend along the posterior median raphe and in man along the median raphe anteriorly to the scrotum. In protracted cases, the skin loses its elasticity and becomes hard, thick and leathery, most probably due to scratching, infection being secondary.

The pathological changes in cases of long duration have been described by Buie and his workers at the Mayo Clinic, showing proliferative changes in the epidermis, thickening of the prickle cell layer and often some dilatation of the superficial vessels and lymphatics. Fibrosis in the connective tissue occurs in cases of long standing but no changes are seen in the cutaneous nerves. Cocci may be found just beneath the ulcerated regions, but not under intact epidermis.

On the first visit to the clinic, patients with pruritus have a history taken and then a thorough examination is made of the anal and perineal regions, followed by a complete anoscopic and sigmoidoscopic examination. Frequently, because the rectal ampulla is clogged with feces, this latter examination cannot be done until a cleansing enema is given. Before returning for a second visit both urine and blood Wassermann examinations are made and where indicated blood chemistry is also done.

The rule at the clinic is to find the cause, which in numerous chronic cases is not always done until after weeks or months of observation. Whether or not the cause of the itching has been determined, its symptomatic treatment must start immediately even though only palliative, while the treatment of the causative condition is being carried out.

Four cardinal points are impressed on a patient when treatment is started:

1. Avoid scratching as much as possible. Impress each patient with the fact that the more they scratch, the longer the treatment will take and the greater will be the damage to their skin.

2. Keep the parts clean, washing with plain warm water after every bowel movement.

3. Keep the parts dry by means of a dusting powder. For this we advise patients to use common ordinary cornstarch two or three times a day and after defecation.

4. The rectal ampulla must be "kept clean." Patients with rectal constipation are instructed to take either an epsom salts

enema or an enema with plain water, preferably at night, before retiring. It has been my experience in pruritus ani, that mineral oil should be avoided because of the leakage.

Either 10 per cent iodine in glycerine or compound tincture of benzoin is applied locally. In fissures, 10 per cent silver nitrate or ichthyol in glycerine is applied. Ointments are rarely prescribed, although numerous anti-pruritic ointments have been used in the treatment of this condition. In this series of cases, we have used ointments in only 6 cases.

X-ray irradiation has been advocated in the treatment of pruritus ani, but the necessity for its use has not been proved, although 2 of the patients in this series had received x-ray therapy previously. It is generally accepted, that patients who have received x-ray irradiation are poor subjects for the subsequent surgical removal of any existing rectal pathology.

INJECTION METHODS

It can be safely stated that we have been liberal and unbiased in trying the various

TABLE II

|   | Cases | Number of Injections |
|---|-------|----------------------|
| 1. 1-3000 sterilized hydrochloric acid Hanes' method..... | 2     | 2                    |
| 2. Absolute alcohol (Stone).....                          | 8     | 18                   |
| 3. 5 per cent phenol in oil in perianal region.....       | 20    | 33                   |
| 4. Benacol (Yeomans, Gorsch, Matthesheimer).....          | 30    | 48                   |
| 5. Patient's whole blood injected in perianal region..... | 2     | 3                    |
| 6. Quinine and urea— $\frac{1}{2}$ per cent.....          | 2     | 2                    |
| 7. Triple distilled water (Bacon).....                    | 1     | 2                    |
| 8. Anucaine.....  | 52    | 158                  |
| 9. Nupercaine in oil.....                                 | 1     | 3                    |

solutions which have been advocated for subcutaneous injections for the treatment of pruritus ani, aiming to obtain either the obliteration of the tissue spaces and the channels filled with irritating fluid that are alleged to be present in severe pruritus, or

the production of cutaneous anesthesia. Table II lists the solutions used.

The technique of each advocate has been followed in these injections. While the number of cases has been limited in which some of these solutions were used, the best results have been obtained with anucaine and we have used this exclusively for the last year. The objection to the use of some of these solutions has been the pain after injection. In some of these early cases more than one solution was used.

Anucaine acts as a local anesthetic for a period varying from four days to three weeks. No untoward results have been noticed from its use, although we have seen 2 cases of induration over the area injected which lasted for about a month but did not produce any abscess. Sloughing was not seen in any case in which anucaine was used. Frequently patients complain of pain over the injected area one or two hours after injection which subsides after a warm sitz-bath.

SURGERY

We have resorted to local surgery in 48 cases of the series, as shown in Table III,

TABLE III

|  | Number of Cases |
|--|-----------------|
| 1. Removal of skin tabs or hypertrophied skin folds.....               | 30              |
| 2. Excision of external hemorrhoids.....                               | 21              |
| 3. Fissurectomy.....   | 12              |
| 4. Removal of hypertrophied papilla.....                               | 10              |
| 5. Removal of polyps.....  | 6               |
| 6. Incision and drainage of abscess of posterior triangular space..... | 2               |
| 7. Undercutting operations.....  | 2               |

but none of the patients have been hospitalized. It must be remembered that frequently each case had more than one operation performed, dependent on the condition present.

RESULTS

In a condition such as pruritus of the anal region, the accurate evaluation of results is not easy owing to the lack of cooperation on the part of the patients and their tendency to discontinue treatments.

Only those patients have been considered cured where the skin changes were entirely cleared and the itch was present no longer. Failures were classed in those patients in whom itch persisted, whether or not any appreciable change was found in the perianal region.

Of the 78 patients considered cured, 12 have had a recurrence of perianal itching. Of these only 4 showed any appreciable skin changes. Upon questioning the 12 patients with recurrences, they all admitted a "let down" in their rectal hygiene but the itching subsided when they resumed cooperation.

TABLE IV

|               | Number of Cases | Per Cent |
|---------------|-----------------|----------|
| Cured.....    | 78              | 59.5     |
| Improved..... | 20              | 15.3     |
| Failure.....  | 33              | 25.2     |
| Total.....    | 131             |          |

| Type of Treatment Employed   | Cases | Per Cent |
|--|-------|----------|
| Cured  |       |          |
| 1. Rectal hygiene and local treatment..                                | 19    | 24.5     |
| 2. Rectal hygiene, local treatment and injection methods.....          | 35    | 44.8     |
| 3. Rectal hygiene, local treatment, injection methods and surgery..... | 24    | 30.7     |
| Total cured.....   | 78    |          |
| Improved   |       |          |
| 1. Rectal hygiene and local treatment..                                | 1     | 5        |
| 2. Rectal hygiene, local treatment and injection methods.....          | 9     | 45       |
| 3. Rectal hygiene, local treatment, injection methods and surgery..... | 10    | 50       |
| Total improved.....  | 20    |          |

It is interesting to note the number of visits patients made to the clinic before they were pronounced cured. The average was 15 visits, the minimum being 6 and the maximum being 142 visits. Of the improved cases we have one patient who made 189

visits during this eight year period and while she does not complain of any itching for the past year, she still has skin changes which does not answer our criteria of a cure. Of the patients classed as failures, the number of visits ranged from 1 to 22.

No attempt is made to enumerate all the etiological factors in these 131 cases, because many of these patients have more than one cause. In 14 cases or 9.35 per cent, however, no rectal pathology could be detected other than rectal constipation.

Table IV gives a resume of our cases and the type of procedure we followed.

In 18 of the failures no diagnosis was made as to the cause of the pruritus, as the patients did not return to the clinic for further study. Of the remaining 15 failures, 7 had injection treatment and 8 had injection treatment plus local surgery. In this last group, 2 patients were diabetics and 2 had a four plus Wassermann.

#### CONCLUSIONS

There is sufficient evidence in this series to warrant the following conclusions:

1. Rectal constipation is one of the most common causes of pruritus ani and most of the cases previously reported as idiopathic fall into this group.

2. Pruritus ani can be cured or improved if one persists in finding the cause and eradicating it, thereby breaking up this so-called vicious cycle of scratching.

3. If conservative measures, including local surgery, fail to give relief of any existing rectal pathology, then injection of anucaine is frequently beneficial.

4. The importance of rectal hygiene is stressed.

#### REFERENCES

- BACON, HARRY E. *Tr. Am. Proctol. Soc.*, (May) 1936.  
 BUIE, LOUIS A. Mayo Clinic Monographs, 1931.  
 HANES, GRANVILLE S. *Tr. Am. Proctol. Soc.*, p. 1, 1922; p. 122, 1928.  
 MURRAY, DWIGHT. *Am. Jour. Surg.*, 34: 26-31, 1920.  
 STONE, H. B. *Johns Hopkins Hosp. Bull.*, 27: 242, 1916; *Surg. Gynec. and Obst.*, 42: 565, 1926.  
 YEOMANS, F. C., GORSCH, R. V. and MATHESHEIMER, J. L. *Tr. Am. Proctol. Soc.*, 1927.

# FOREIGN BODIES IN RECTUM

JEROME WAGNER, M.D.

Adjunct Professor of Proctology, New York Polyclinic Medical School and Hospital

NEW YORK

**T**HIS morning while I was having a bowel movement I suddenly felt a sharp, cutting pain in my rectum. It felt as though I was stabbed with a knife. Now (1:30 P.M.) there is only a soreness in my rectum. I didn't see any blood and it is the first time that anything like this has happened to me. My stool was not unusually hard this morning and as a general rule my bowels move twice a day.

This was the story of a man of forty-five years, told in the Proctological Clinic at the New York Polyclinic Hospital. There was nothing in his past history that had any bearing upon his story. This story would lead one to suspect a tear of the anal or rectal mucosa. An examination was made and an inspection of the anal region revealed nothing. A digital examination was then made and about 2 cm. above the anus a long, thin object was felt, apparently a bone. A speculum was inserted and with an alligator-jawed forceps a thin chicken-bone, about 5 cm. long was removed. More detailed questioning of the patient then revealed the fact that he recalled having eaten chicken three days before. Removal of the foreign body brought immediate relief and there were no subsequent symptoms.

This case is used in order to illustrate a class of cases where a foreign body may be present in the rectum without the patient being able to give any intimation as to the reason for its presence and in which the removal of the foreign body is a simple procedure.

I have been severely constipated for the last year. This began when I suffered from acute gastritis about a year ago. Night before last I was taking an enema when suddenly I felt a very sharp pain in the rectum, just as though I had torn something. I didn't see any

blood but since then I have had a lot of pain whenever I sit down.

This was the story of a male of forty-seven years, who had been referred by the department of Cardiology in the New York Polyclinic Hospital to the department of Proctology. Further questioning failed to add anything important to the quoted history except that he had never had similar symptoms. The examination revealed upon inspection a rosette of hemorrhoids. A digital examination revealed a very marked sphincteric spasm. The finger inserted into the rectum also ascertained the presence of a sharp pointed bone-like projection in the anterior wall above the prostate.

A one per cent solution of novocaine was introduced into the sphincter to produce relaxation. Following this a speculum was inserted and a flat fish-bone about 2.5 long and 1 cm. in width, was removed. There were no after symptoms. This patient recalled having eaten fish three or four days before.

This case, while similar in most respects to the first case noted, differed in that, in order to remove the foreign body, it was necessary to administer a local anesthesia.

We now come to a class of cases that belong in a different category namely, where the patient knows that he has swallowed a foreign body and recognizes that this has become a foreign body in the rectum as soon as symptoms develop. Such a case came to the writer about seven o'clock one evening with the following story:

Night before last while eating dinner, I swallowed a chicken-bone. It did not bother me and I forgot about it until about a half hour ago when, as I started to eat dinner I suddenly felt a sharp pain in my rectum. I

guess it is the chicken-bone. It still hurts and it feels as though there is something in my rectum although the pain is not as sharp as at first.

Inspection revealed nothing, but upon digital examination a small sliver of bone could be felt just above the sphincter muscle and by crooking the examining finger the foreign body was expelled with the finger. It was a small chicken-bone, apparently about 2.5 cm. long and a couple of millimeters in thickness.

Then there is the class of cases in whom the foreign body in the rectum has been introduced through the anus. The following is an illustration:

A patient at Bellevue Hospital told Dr. Cowett the following story:

I have been having trouble with my prostate a long time which necessitated my going to a doctor twice a week to have my prostate massaged. I was running low in funds so I devised a way to massage my own prostate. I cut off eight inches of a broom handle, then four inches from the rounded end I cut the broom handle to half its thickness, leaving about four inches to insert into the rectum and the thinner four inches was a handle for me to grip. I have been massaging my prostate with this, and this morning while doing this it broke at the point where I had made the broom handle thinner. The other piece has remained in my rectum.

Examination revealed the presence of the broken piece in the rectum, and under general anesthesia and free dilatation of the sphincter the broken piece was removed.

From the brief illustrations given it will be seen that foreign bodies in the rectum fall under the following categories:

1. Where the foreign body has been introduced through the mouth without the patient's knowledge;
2. Where the foreign body has been introduced through the mouth with the patient's knowledge;
3. Where the foreign body has been introduced directly into the rectum through the anus. Under this latter heading might be added that a foreign body might be present

in the rectum, introduced through the anus without the patient's knowledge although this occurrence is rare.

4. There is yet one class of foreign bodies which may occur and which may not have been introduced either through the mouth or through the rectum but have been formed within the body. These are the so-called stercoliths or fecal calculi. One would expect to find them in cases of chronic constipation. The usual composition is a mixture of inspissated feces and inorganic salts and the nucleus a foreign body such as a fruit stone although the presence of the latter is not essential. One of the peculiar and characteristic symptoms of the presence of this condition is the involuntary passage of liquid stools. Diagnosis, of course can be made only by a careful rectal examination. When the nature of such a condition is ascertained it is better to attempt to soften and break up the mass than to attempt to remove it en toto. A favorite method to break up such a mass is a solution of hydrogen peroxide introduced as an enema. As the peroxide soaks into the mass, bubbles of gas form in its substance and break it up. Having broken the mass, an enema removes the debris.

#### SYMPTOMS

Symptoms of a foreign body in the rectum are first and foremost, pain. The natural reaction of the rectum to the presence of a foreign body is to expel it. This effort is undoubtedly what causes the onset of pain, particularly if the foreign body is sharp, or, if not sharp, of sufficient size to prevent expulsion. Bearing in mind that only the lower 2 inches of the rectum is rich in sensory nerves, the presence of pain is a good indication as to the location of the foreign body. Other symptoms may be; bleeding, due to trauma caused by the foreign body, or obstruction to free passage of the fecal current because of the size and nature of the foreign body. It must also be borne in mind that owing to the sensory nerve distribution which is common to the



lower rectum, urethra, neck of the bladder and vagina, that there may be pain in any of the parts just mentioned. It is even possible for pain to be referred to the inner side of the knee or the hip-joint because of this same nerve distribution. If the foreign body should be very large and exerts sufficient pressure upon the posterior wall of the rectum, this pressure upon the sacral plexus might cause a variety of pains.

#### DIAGNOSIS

This should be simple. A good history is important. Digital examination may reveal the foreign body, but should it not, a speculum, preferably one with a light, may reveal the foreign body. If neither of these methods succeed and if one is convinced that a foreign body is present, the radiograph must be the next resort.

#### TREATMENT

This will depend entirely upon the nature of the foreign body. Of course its removal is the first consideration. In planning the procedure for removal the important fact to be borne in mind is that the removal should be accomplished with a minimum of trauma. The larger and more irregular the foreign body the more serious is this danger. Unquestionably the first step is to produce a relaxation of the sphincter, which may be most readily accomplished by an infiltration of the sphincter muscle with some local anesthesia, such as novocaine or procaine. If the foreign body is small and not deeply embedded it may be extracted with the index finger without causing any unnecessary damage. If, however, this cannot be done, the wise procedure is to introduce a speculum. With the patient in the left knee-chest position, a Humphries speculum or if that is not available an ordinary Sims speculum will give a good exposure of the lower end of the rectum. Should such a speculum not give an exposure sufficiently high then it will be necessary to use some tubular speculum with an auxiliary light, such as the Lynch speculum. Through this the body may be grasped with a forceps

and brought down through the speculum. Should the foreign body be larger than the lumen of a speculum or multiple such as, for instance many pieces of broken glass other procedures may be necessary. Continuous irrigation with water is suggested, or the introduction of gauze in the latter instance hoping that the small spicules of glass will adhere to the irregular mesh of the gauze. However, instances may arise where more drastic surgery will prove necessary, even to the point where the abdomen may have to be opened and by pressure from above, the foreign body may be expelled through the anus. It may be of passing interest at this point to mention a few of the varieties of foreign bodies that have been found in the rectum.

Morand, in his memories of the Academy of Surgery in Paris, tells of a monk who, to cure a violent colic introduced a bottle into his rectum with a small opening in its mouth by which its contents, drop by drop, could enter the intestines. The bottle could not subsequently be removed and it was necessary to secure a boy with a small hand to extract the bottle. Hevin tells of some students who introduced the frozen tail of a pig into the anus of a French prostitute. The bristles were cut short and being lubricated with oil, this tail was introduced with great force into the rectum, allowing a portion of the tail to protrude. Great pain followed. Efforts to remove the tail proved unsuccessful. On the sixth day Marchettis succeeded in removing it by passing a hollow reed into the rectum outside of the bristles and then removing reed and tail together. Studsgaard mentions a smooth stone, 17 cm. long, weighing 900 grams which a peasant had introduced into his rectum to relieve prolapse.

A convict at Brest, put a box of tools up his rectum. He died seven days later. At postmortem the box was discovered in the transverse colon. It was a cylindrical box of sheet iron covered with skin, 6 inches long, 5 inches broad and weighed 22 ounces. There are records of many more various and curious objects found in the rectum.

but the few that have been mentioned will indicate the variety. Because of the ingenuity used in the removal of a foreign body the following may be of interest: A man was a victim of rowdy companions. The following day, while searching within the rectum to determine the cause of certain unusual symptoms, he located something that felt like the edge of a glass. Manual manipulations failed to dislodge the intruder, so he tried a thumb forceps which snipped off a particle of the edge of the glass which left a serrated edge. The following method or removal was then used:

Pieces of gauze were dipped in plaster-of-Paris paste, and inserted into the hollow glass with a long dressing forceps through a speculum until the glass was packed overfull. The last strip was sufficiently long to leave more than 12 inches free for traction. Within half an hour the plaster was solid. As traction was made, small particles of loose hardened plaster preceded the glass,

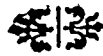
and fragments and splinters were incorporated with them. No difficulty was experienced in bringing the glass to the sphincter. This was dilated with a vaginal speculum, and the foreign body was withdrawn with but little resistance and no bleeding. The object proved to be a common 5 ounce "high-ball" glass. The victim, a marine engineer, returned to duty the next day.

#### SUMMARY

1. A foreign body in the rectum may come to anyone's attention at anytime, but in most instances it will be a small object, swallowed with food, such as a fish-bone or chicken-bone.

2. Diagnosis is not difficult because of the almost uniform exactness of symptoms, viz., a sudden, sharp stabbing pain near the anus and the subsequent localization by an examining finger, of a foreign body.

Treatment is removal, bearing in mind the problem of trauma to the tissues.



# PILONIDAL CYSTS: EXCISION AND PRIMARY SUTURE IN AMBULATORY PATIENTS\*

L. K. FERGUSON, M.D., F.A.C.S. AND PAUL M. MECRAY, JR., M.D.

Associate in Surgery,  
University of Pennsylvania

Assistant, Surgical Out-Patient Department,  
Hospital of University of Pennsylvania

PHILADELPHIA

**A**MONG the lesions cared for by the general surgeon and the proctologist, there are few conditions which give such unsatisfactory end results as the treatment of pilonidal cysts and sinuses. Following the customary procedure of excision en bloc and packing, the incidence of recurrence is high, the period of hospitalization is long, the subsequent period of redressing is extended, and frequently the end result is a large painful scar. It is the purpose of this paper to report further<sup>1</sup> upon a method of treatment of pilonidal cysts and sinuses in ambulatory patients which has given us permanent cures in 92 per cent of our cases, and an average healing period of 17.4 days from the time of operation. By this method of treatment our patients have lost an average of two days from work.

By definition, a pilonidal cyst is a congenital anomaly consisting of a cyst or a sinus lined with stratified squamous epithelium and frequently containing hair. It is located in the midline just above the coccyx. It does not communicate with the rectum and usually is not recognized until after puberty, when attention is focused upon it by the symptoms of infection.

Probably the first description to be found in the literature was written in 1847 by Dr. A. W. Anderson<sup>2</sup> of Gray, Maine. He stated that his patient was a "young man, aged twenty-one years (who) said he had a scrofulous sore on his back which he believed would use him up." From the "ulcer" Dr. Anderson extracted hair. Hodges,<sup>3</sup> writing in 1882, suggested the name pilonidal cyst. In the European literature, it is usually referred to as sacro-

coccygeal cyst or sinus. Other terms that have been used are pilous cyst, sacrococcygeal fistula and sacrococcygeal dermoid.

## ETIOLOGY

Many theories have been offered to explain the etiology of pilonidal cysts. Warren,<sup>4</sup> in 1867, gave the first explanation of the etiology of these lesions when he suggested that they might be the result of "hairs becoming diverted from their normal direction (due to pressure) and inverting themselves in the follicle." Terrillion,<sup>5</sup> in 1882, proposed two theories: first that the cysts might be the vestiges of a "posterior umbilicus," and second that they might be the result of a spina bifida, "a son plus faible degré de développement," involving the skin only. In 1892 Lawson Tait<sup>6</sup> proposed that the sinus was due to a "cicatrix of the spina bifida by which the human tail has been lost." Stone,<sup>7</sup> in 1931, drew an analogy with the preen gland of birds, in which he compared the tuft of feathers at the mouth of the gland with hairs protruding from a sinus.

At the present time, there are three chief schools of thought regarding the etiology of pilonidal cysts. The first considers that they arise from remnants of the neural canal. Two explanations for this have been suggested. The earlier theory, that proposed by Feré,<sup>8</sup> suggested that closure of the neural canal might not be complete and bits of its lining might be cut off and later develop as a sequestration cyst. The more recent and more popular theory was proposed by Tourneaux and Herrmann<sup>9</sup> and has been elaborated by Wendelstadt<sup>10</sup> and Mallory.<sup>11</sup> Briefly, these writers maintain

\* From the Surgical Out-Patient Department, University of Pennsylvania Hospital.

that in the development of the neural canal its threadlike tip is left attached to the skin at its caudal end. As the fetus develops, the spine grows more rapidly than the skin, pulling the attached end superiorly and posteriorly so that it describes a U around the coccyx. The tip of this filum terminale finally reaches the level of the third sacral vertebra. After the fifth fetal month the structure atrophies, but Mallory found remains of it in full term fetuses. Its epithelium may develop to form cysts and, as Perman<sup>12</sup> states, may regain its original squamous character.

The second theory was suggested by Lannelongue.<sup>13</sup> He noted in the embryo that the skin over the coccyx is in firm juxtaposition to the bone, with no intervening mesoblast. In later development, the surrounding mesoblast gives rise to the abundant subcutaneous tissues forming the nates. This causes a dimple to be left over the coccyx. Exaggeration of this dimple would cause a sinus, and overgrowth of epithelium at the mouth might lead to cyst formation. Oehlecker<sup>14</sup> modified this theory by adding the factor of disproportionate growth of skin and spinal cord with the result that the skin is pulled anteriorly and caudally.

The third theory considers that pilonidal cysts are due to imperfect coalescence of the lateral halves of the body. It was probably first discussed by Lamadrid<sup>15</sup> in 1872; it has had the support of Bland-Sutton<sup>16</sup> and other writers and is the most popular theory among the clinicians.

Arguments against the neural rest theory are: (1) the general absence of nerve tissue in the pathological sections from pilonidal cysts; (2) the universal presence of squamous epithelium as the cyst lining; (3) the absence of any dermoid structures other than hair and sebaceous material. Case reports of meningitis originating from an infected pilonidal cyst,<sup>17,18</sup> and the report of a case where spinal fluid gushed out during excision of a cyst<sup>19</sup> have been offered as arguments against the second and third theories. Fox<sup>20</sup> noted that according to

Oehlecker's theory the tract should be directed downward instead of its universal cephalad direction. A very interesting paper<sup>21</sup> has been presented within the past year, suggesting that there may be two etiological possibilities: neural rests giving rise to pilonidal cysts, and invagination of epithelium producing sinuses and more rarely cysts. Fox disagrees with this. In his paper he traces the evolution of ectodermal invaginations through a series of embryos. He shows that while the coccygeal medullary vestiges do exist they do not form pilonidal sinuses; if they do appear, they form tumors. He believes that pilonidal sinuses are due solely to ectodermal invaginations carrying with them all their normal structures.

#### FREQUENCY

The frequency of admissions for pilonidal cysts in a general hospital has been given by Dulligan<sup>22</sup> as 0.1 per cent. Breidenbach and Wilson<sup>23</sup> have recorded the incidence at Bellevue as 0.06 per cent of all admissions. Kline<sup>24</sup> in a general hospital for veterans quoted the frequency at 0.5 per cent. Patients presenting themselves with pilonidal cysts have constituted 0.9 per cent of the admissions to the Surgical Out-Patient Clinic of the Hospital of the University of Pennsylvania during the past six years. Excision and primary suture of pilonidal cysts has constituted 1.2 per cent of operations performed in that clinic. This high frequency may perhaps be accounted for by the large number of young adults attending the University of Pennsylvania and also by the known interest of the writers in this condition.

The white race is the most frequently afflicted with pilonidal cysts. No cases have been reported in Mongolians or American Indians and but 6 cases have been recorded in the Negro (Smiley,<sup>25</sup> 1; Fansler and Anderson,<sup>26</sup> 1; Breidenbach and Wilson,<sup>23</sup> 4). Males are more frequently subject than females. Ravdin and Johnston<sup>27</sup> have collected 505 cases from the literature, of which 75 per cent were males. Numerous

writers have mentioned the higher incidence in hairy individuals. Ottenheimer<sup>28</sup> states that they occur in obese individuals

follicles and sweat glands have been observed in the depth of a sinus. A photomicrograph of a section from this case is presented (Fig. 1).



FIG. 1. Section through the deep portion of a pilonidal cyst, showing hair follicles (1), sweat glands (2) and foreign body giant cells (3). Note the well formed squamous epithelium forming the cyst surface in upper left hand corner.

with a suggestion of endocrine imbalance. This has not been the experience of the present writers.

A hereditary tendency towards pilonidal cysts has not been proved. Breidenbach and Wilson were able to find only 5 patients in 288 who had a family history of these lesions. However, Mechling<sup>29</sup> reported sinuses in twenty-three year old twins, and Smiley<sup>25</sup> noted them in a father and his three children.

#### PATHOLOGY

Associated congenital lesions are unusual. Frank Glenn<sup>30</sup> roentgenogramed 19 patients with pilonidal cysts and found only 2 cases of spina bifida occulta. Breidenbach and Wilson state that they have never seen hair follicles, sebaceous or sweat glands in any of their specimens. They believe that the persistence of an erroneous observation of Crone<sup>31</sup> accounts for the description of these structures in the literature. Review of the sections from all specimens removed at the Hospital of the University of Pennsylvania in the past year shows but one case in which hair

#### SYMPTOMS

The presenting symptoms are usually those of acute inflammation. A history of recurrent abscess formation is frequent. More rarely one finds a long continued discharge and pruritis as the only symptoms. Still more unusual is the patient who presents himself because of a lump above the anus. Trauma is nearly always the factor in initiating the inflammatory reaction in a previously quiescent cyst.

#### DIAGNOSIS

The diagnosis is simplified if one keeps the condition in mind. The index of suspicion is high when there is an abscess in the midline over the sacrum and above the anus. A probe introduced into a pilonidal sinus will not pass into the rectum, but, in contrast, will take a cephalid and anterior course. The extraction of hair from the sinus is diagnostic. Differential diagnosis must be made from perirectal and ischio-rectal abscesses, from fistulas in ano, from infected sebaceous cysts, from furuncles and many other less frequent conditions. In the writers' experience, the most difficult differential diagnosis has been from sacrococcygeal dermoid. Recently, a patient presented himself with a history of four previous operations supposedly upon a pilonidal sinus. He presented a moderately acutely inflamed area in some scar tissue over his sacrum. The lesion was exquisitely tender and fluctuant. It was incised and drained under the impression that it was an infected pilonidal sinus. At this time the operator observed that purulent material was coming from a sinus which passed through the sacrum to its anterior surface. The deep sinus was packed with iodoform gauze and the patient sent for a roentgenogram (Fig. 2).

## TREATMENT

Considerable controversy has arisen in the literature with regard to the most

the operation of excision was performed on an infected cyst or sinus, which made primary infection of the resulting wound

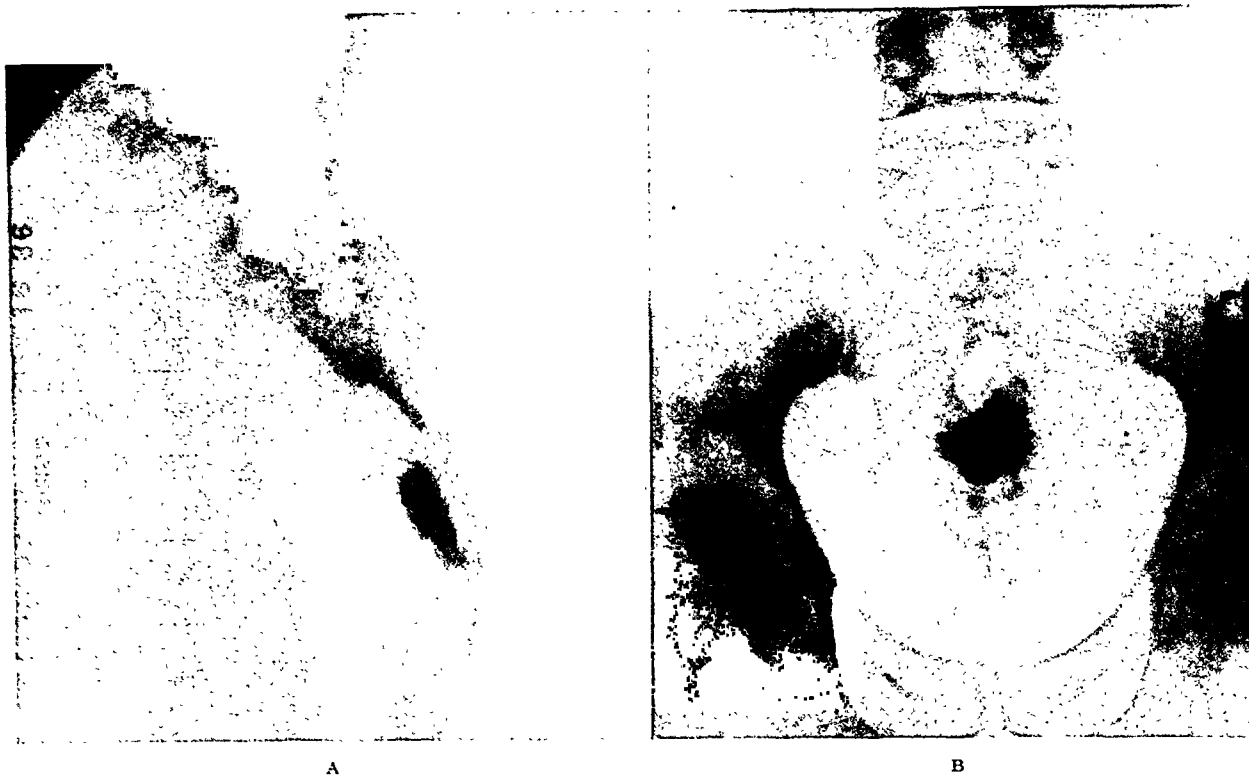


FIG. 2. X-ray picture showing sacrococcygeal dermoid packed with iodoform gauze. This cyst extended by a narrow opening through the sacrococcygeal joint and produced a smooth, painful, fluctuant swelling over the lower sacrum. It had become painful due to recent trauma. The cyst was operated upon with the mistaken diagnosis of pilonidal cyst and represents one of the rare lesions of this region which may be confused with pilonidal cysts.

successful method of treating pilonidal cysts and sinuses. The treatments most commonly employed have been: (1) excision with packing of the wound, permitting healing by granulation; (2) excision with partial suture and packing or drainage; and (3) excision and primary suture. Recently, Rogers and Hall<sup>32</sup> have proposed cautery excision with packing and healing by granulation. The accompanying table gives a comparison of these various types of treatment, tabulated according to the days in the hospital, days lost from work, length of healing period and results (Table 1).

In reviewing the histories of these cases it became apparent that a necessary hospitalization of one or two weeks with a healing period of four to twelve weeks, was too long a period of disability for the treatment of a superficial infected sinus or cyst. The difficulty seemed to lie in the fact that

almost certain and, because of the location of the wound, secondary infection very probable. In addition, an accurate excision of the entire infected tract was made more difficult by the presence of inflammation. It seemed logical then to treat the infection and accompanying inflammation first, and later to perform an excision of the sinus tract.

## TREATMENT OF INFECTION AND INFLAMMATION

Our treatment then consisted of incision and drainage of the infected sinus or cyst under local anesthesia as a primary procedure, and usually applications of hot wet dressings twice daily during the first forty-eight hours after operation. The loose gauze packing was removed on the third day after incision and healing was permitted to take place. In more than half of our cases,

adequate drainage was obtained by dilating the sinus opening with a hemostat, or by the simple application of hot wet dressings.

With sharp rakes as retractors, the incision is deepened to isolate the sinus opening entirely. An Allis forceps is then applied

TABLE I

| Author                 | Type of Treatment                                | Days in Hospital            | Average Days from Work | Average Healing Period | Per Cent Cures  |
|------------------------|--|-----------------------------|------------------------|------------------------|---|
| Breidenbach and Wilson | Excision and packing                             | 8                           | at least 8             | 6-12 weeks             | 94.<br>(132 operations, 32 patients followed, 30 cures) |
|                        | Excision, suture, drainage or packing            | 9.1-11.6                    | 9-12                   | 6-12 weeks             | 64.   |
|                        | Excision and suture                              | 8.4                         | 8-9                    | 6-12 weeks             | 56.   |
| Rogers and Hall        | Excision; partial or complete closure or packing | 10.9-13.4                   | 11-14                  | 2.7-3.5 months         | 56.-61.   |
|                        | Cautery excision, packing                        | 1 day for 34 of 50 patients | 7                      | 2.7 months             | 100.<br>(29 cases, 8 months or less postoperative)      |
| Ferguson and Mecray    | Excision and packing* or Lahey operation         | 6-12                        | 14                     | 4-10 weeks             | 50.   |
|                        | Excision and primary suture                      | 0                           | 2                      | 1-3 weeks              | 92.   |

\* FERGUSON, L. K. *Ann. Surg.*, 101: 469, 1935.

As a rule, the wound was entirely healed in two to three weeks. The patients were ambulatory throughout this period of treatment and most of them continued to follow their usual daily activities.

#### TECHNIQUE OF EXCISION AND PRIMARY SUTURE

After the primary infection had been controlled and the inflammatory reaction had completely subsided, the cyst and sinus tracts were excised and the wound closed by primary suture. The technique of the operation of excision is simple. A wall of novocain-adrenalin is injected by infiltration around and under the sinus tract and cyst. The incision is then begun in the midline over the sinus tract and continued downward to surround the sinus opening.

to close the sinus orifice and to serve as a tractor on the tissue to be removed. With the tissue constantly on tension, the dissection is then carried upward, surrounding the sinus and cyst. The line of separation from fascia overlying the sacrum is easily recognized, but the lateral separation must be made by the scalpel. In cases where there are secondary sinus openings, these are dissected out before attacking the main cyst.

After removal of the cyst and sinus, a clean wound remains with normal fatty tissue on the sides and sacral fascia in the base of the wound. Closure is effected in two layers. The first layer is of No. 00 plain catgut, four or five interrupted sutures placed so as to include the fatty tissue on each side of the wound and the sacral

fascia at its base. These sutures are all inserted before any are tied, because the approximation of the wound obtained by

Our experience has shown that primary union is dependent on the obliteration of dead space and the prevention of serum

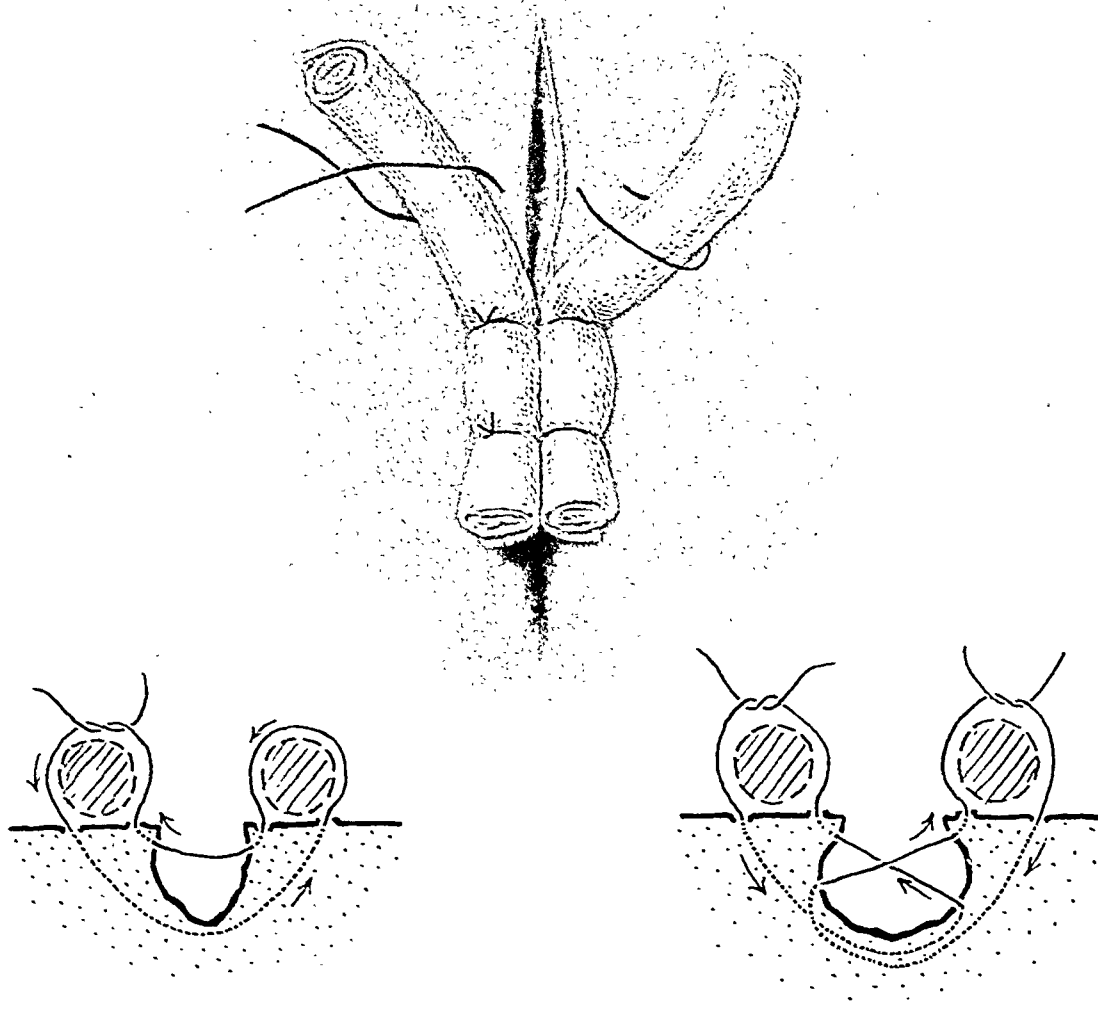


FIG. 3. Method of closure of wound to obliterate dead space. Mattress sutures of alloy steel wire inserted and tied over gauze rolls as shown. Occasionally slight undercutting of the wound edges is necessary to permit good closure.

tying them as they are inserted makes it difficult and even impossible to accurately insert the last two sutures. This layer of sutures obliterates dead space in the base of the wound. The skin is approximated and dead space is further obliterated by the use of mattress sutures of alloy steel wire tied over gauze rolls (Fig. 3). Usually, several interrupted sutures of fine wire are used to aid in the further approximation of the skin edges. A pyramidal-shaped pressure dressing of gauze is applied and held in place with firm adhesive strips.

collections, and to this end, pressure on the wound is further obtained by placing the patient on his back on a litter or operating table for an hour after operation. He is then permitted to go home. Our patients are usually given three  $\frac{1}{6}$ -grain tablets of morphine sulphate to be taken by mouth every third hour if necessary. As a rule, they are not used; most patients experience more discomfort from the adhesive strapping than from the operative wound.

Dressings are inspected on the third day and at this time the interrupted sutures in



the skin are removed. These wounds are prone to become moist and macerated, and the skin around the sutures frequently becomes infected. There is often a redness and induration of the wound at this stage which subsides readily. Gauze moistened in 70 per cent alcohol solution has proved a most satisfactory dressing. On the sixth day the wire mattress sutures are removed and another alcohol dressing applied. The wound is kept under observation for another week. Occasionally, there are small serum collections in the wounds, which usually do not appear until after the mattress sutures are removed, and in many instances drainage of the serum will take place through the stitch holes. Wounds are treated with alcohol dressings and are opened reluctantly, only if spontaneous drainage does not occur. If there is a tendency to maceration of the skin about the wound, zinc oxide ointment is often of value.

This method of therapy has distinct advantages.

1. It is possible to perform the operation under local anesthesia, thus making easily possible the ambulatory care of the patient. If adrenalin hydrochloride (8 drops of the 1:1000 solution to the ounce of 1 per cent procaine) is added to the infiltrated solution, the resultant operative field is practically bloodless, making possible a more rapid operation and a more accurate dissection.

2. The absence of inflammation and the use of adrenalin permits not only a complete and careful excision of the entire tract, but also it is possible to preserve a considerable amount of the normal surrounding fatty tissue, which must be sacrificed if the excision is performed while the cyst is the seat of an acute inflammation. The dissection is carried out without the necessity of injecting the tract with any colored solution. There is no difficulty in differentiating the denser tissue with smaller fat lobules which surrounds the sinus and cyst, from the normal adipose tissue with larger fat lobules which lies adjacent

to it. In addition, leakage of the colored solution into the wound often confuses rather than aids the dissection. The absence of inflammation makes it necessary to remove only a narrow cylinder of tissue, thus making it possible to remove the entire sinus tract and cyst and still perform a primary closure without leaving dead space.

## RESULTS

Thirty-seven patients with pilonidal cysts have been treated as outlined. Five of these were hospitalized for the first twenty-four hours after operation; these were either students who lived alone in dormitories or patients who lived more than an hour's ride from the hospital. All of the others were ambulatory throughout their period of treatment.

*Primary Treatment.* The cyst was incised and drained under local anesthesia in 11 patients. In the remaining 26 cases, the infection was controlled and the inflammatory reaction subsided by either dilatation of the sinus or the simple application of hot wet dressings.

*Immediate Operative Results.* In all cases excision and primary suture were performed. Two wounds had to be reopened because of infection and 2 partially reopened due to trauma. Fourteen wounds had a slight serous drainage and were treated for three or four days with alcohol dressings. The healing periods in the 37 cases are given in Table II.

TABLE II

| Healing Period in Days | 10 or Less | 11-15 | 16-20 | 21-25 | 26-30 | 31-35 | 36-40 | 41-45 |
|------------------------|------------|-------|-------|-------|-------|-------|-------|-------|
| No. of cases.....      | 13         | 8     | 10    | 3     | 1*    | 1*    | 1†    | 1†    |

\* Wounds partially opened by trauma.

† Wound reopened because of infection.

In all but 4 cases the wounds were healed and the patients discharged from our care within three weeks after operation; in more than half the cases, postoperative care was

necessary for less than two weeks (Fig. 4). Postoperative visits averaged 7.6, including those patients with wound complications.

cost of at least eight days bed and board in the hospital with other incidental hospital fees. The short healing period and the rela-

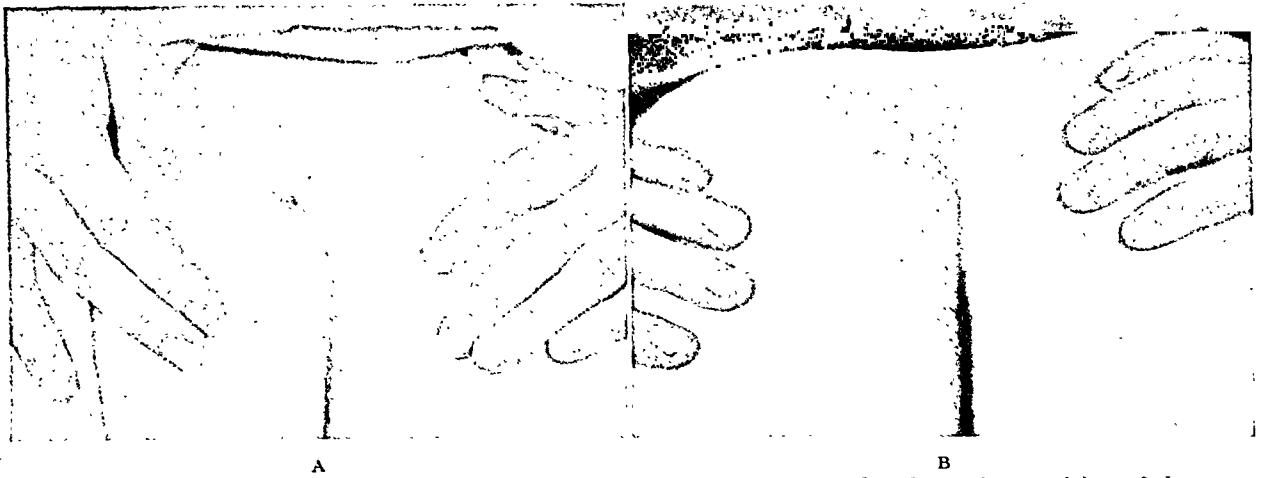


FIG. 4. A, pilonidal cyst with secondary sinus opening; B, same patient twelve days after excision of the cyst and sinus with primary suture of the wound; healing by primary intention.

More than half of the 37 patients had five or less postoperative dressings.

*Permanent Results.* Of the 38 operations (one patient was operated on twice), the results are known in 37 cases. There were 3 frank recurrences, one of which has been reoperated and is now healed more than three years. Two patients had an occasional slight serous discharge from small sinuses, which persisted for several months; these have since completely healed.

All but one patient was able to be traced in a follow-up examination. Thirty-four patients are well and free of symptoms. Eight of these have been operated upon less than one year and are therefore too recent for a final report; the other 26 patients have been well for one to four years. Four of the 26 complain of occasional pain on sitting; it is significant that these patients are those whose wounds were opened either because of infection or trauma.

#### ECONOMIC CONSIDERATIONS

Primary excision and primary suture in ambulatory patients has a distinct recommendation, if the cost of the treatment to the patient is considered. We have estimated that our method of care costs about one-tenth as much as the treatment by excision and packing. There is saved the

tively few postoperative visits save private or clinic fees. The few days lost from work, an average of two days in 38 cases, as compared with ten or twelve days, prevent a loss of income. All of these are savings to be considered by the patient who is paying for his treatment, or by the hospital in cases of charity patients.

#### SUMMARY

1. A review of the etiology and pathology of pilonidal cysts and sinuses has been presented.

2. A method of treatment has been given, of which the essential details are:

- a. Primary control of the infection and inflammatory reaction;

- b. Excision of the cyst and sinus, when free of infection and inflammation, under local anesthesia;

- c. Primary suture of the wound with care to obliterate dead space;

- d. The patient is ambulatory throughout his period of treatment.

3. This method has given good permanent results (92 per cent cures) with few (3) recurrences. The patients had an average healing period of 17.4 days and an average of two days lost from work. The economic advantages to be derived from this form of treatment are pointed out.

## REFERENCES

1. FERGUSON, L. K. *Ann. Surg.*, 101: 469, 1935.
2. ANDERSON, A. W. *Boston Med. and Surg. Jour.*, 36: 74, 1847.
3. HODGES, R. M. *Boston Med. and Surg. Jour.*, 103: 485, 1882.
4. WARREN, J. M. *Surgical Observations with Cases*. Boston, Tecknor and Fields, 1867, p. 192.
5. TERRILLION, M. *Bull. et mém. de Soc. de chir. de Par.*, 8: 54, 1882.
6. TAIT, LAWSON. *Transactions of the Congress for the Advancement of English Science*. Dublin, 1877 (quoted from Terrillion).
7. STONE, H. B. *Ann. Surg.*, 94: 317-320, 1931.
8. FERÉ, C. *Bull. Soc. anat. de Par.*, 53, 1878.
9. TOURNEAUX, F. and HERRMANN, G. *Jour. de l'anat. et de la physiol.*, 23: 498, 1887.
10. WENDELSTADT, H. *Dissertation*, Bonn, 1885.
11. MALLORY, F. B. *Am. Jour. Med. Sc.*, 103: 263, 1892.
12. PERMAN. *Langenbeck's Arch.*, 1895.
13. LANNELONGUE. *Bull. et mém. Soc. de chir. de Par.*, 8: 185-194, 1882.
14. OEHLCKER, F. *Ztschr. f. Chir.*, 197: 262, 1926.
15. LAMADRID, J. J. *Philadelphia Med. Times*, 3: 699, 1873.
16. BLAND-SUTTON, J. *Ann. Surg.*, 10: 81, 1889; *Jour. Anat. and Physiol.*, 20: 433, 1886.
17. MOISE, T. S. *Surg., Gynec. and Obst.*, 42: 394, 1926.
18. RIPLEY, W. and THOMPSON, D. C. *Am. Jour. Dis. Child.*, 36: 785, 1928.
19. WEEDER, S. D. *Ann. Surg.*, 98: 385, 1933.
20. FOX, S. L. *Surg., Gynec. and Obst.*, 60: 137, 1935.
21. GAGE, MIMS. *Arch. Surg.*, 31: 175, 1935.
22. DULLIGAN, P. J. *Am. Jour. Surg.*, 6: 554, 1929.
23. BREIDENBACH, L. and WILSON, H. L. *Ann. Surg.*, 102: 455, 1935.
24. KLINE, L. B. *Med. Bull. Vet. Admin.*, 11: 241-246, 1935.
25. SMILEY, K. E. *Am. Jour. Surg.*, 27: 289, 1935.
26. FANSLER, W. A. and ANDERSON, J. K. *Minn. Med.*, 17: 146-147, 1934.
27. RAVDIN, I. S. and JOHNSTON, C. G. *Am. Jour. Med. Sc.*, 190: 280, 1935.
28. OTTENHEIMER, E. J. *Am. Jour. Surg.*, 21: 121, 1933.
29. MECHLING, C. C. *J. A. M. A.*, 102: 367, 1934.
30. GLENN, FRANK. *New England Med. Jour.*, 207: 554-556, 1932.
31. CRONE, E. *Münche. med. Wchnschr.*, 64: 521, 1917.
32. ROGERS, H. and HALL, M. G. *Arch. Surg.*, 31: 742-766, 1935.



# ISCHIORECTAL ABSCESS

## A CONSIDERATION OF THE ORIGIN AND THE TREATMENT

S. JUDD BOCHNER, M.D.

Instructor in Surgery, New York Post-Graduate Medical School, Columbia University; Assistant Surgeon, New York Post-Graduate Hospital

NEW YORK

**I**SCHIORECTAL abscess almost invariably means that an anal cryptitis has been overlooked; for 90 per cent of all para-anal inflammatory disease is of non-specific origin and directly traceable to an acute cryptitis. Acute cryptitis does not present a complicated picture either for diagnosis or treatment, nevertheless the amazing frequency with which its disabling sequels enter the office and clinic must bring about a reconsideration of the problem.

Review of 100 consecutive cases of ischiorectal and pararectal abscess seen at the New York Post-Graduate Hospital rectal clinic, showed that 44 patients had as their chief complaint the discharge of pus from an already existing fistula or sinus varying in duration from two days to four years; 23 of these people had had one or more previous operations for abscess without relief. In questioning these people, it appeared that three factors must play a part in this picture: (1) delay on the part of the patient in consulting his doctor, (2) delay on the part of the doctor, and (3) incomplete therapy. Social taboos on the discussion of anal disease makes difficult the dissemination of information that might bring the patient to the doctor sufficiently early for the disease to be a simple problem. Neglect at this "golden period" of rectal surgery, however, is not altogether the fault of the patient, for not infrequently he tells the story of having consulted a doctor and of having been given a salve or a lotion for the tell-tale para-anal itch, a cathartic for his constipation and admonition to return in two weeks. Only too often it is apparent that a proper rectal examination had not been done.

Anal crypts form pockets at the bottom of each of the columns of Morgagni. They take origin in the transitional epithelium of the intermediate zone and therefore are lined by tubular glands, more usually known as anal ducts. The mouths of the crypts are in part protected by the folds and papillae of the columns.

Acute cryptitis is a primary inflammatory disease of the glands of the crypts. As the process continues the crypt becomes edematous and filled with pus. The papillae are swollen, elongated and even take on a polypoid character. Exudate forms a mat about the swollen papillae effectively sealing the mouth of the crypt, and the mechanism is completed for the formation of a submucosal abscess. *Para-anal itching and burning* appear early in the disease, for the purulent discharge is decidedly irritating. We often hear the mother say, "There is something wrong with Billy. He is always scratching himself." *Pain on defecation* appears at a later stage of the disease, that is, when abscess has formed; the cryptitis has become sealed off forming an intramural inflammatory mass.

The rectal examination will invariably expose a cryptitis or submucosal abscess. The patient should be either in the knee-chest position, with knees well separated, or well over in the left Sims position. The presence of hemorrhoids or fissure need not confuse the picture as they are incidental rather than causative in their relationship. The finger will elicit a single point of tenderness and possibly define the abscess as a mass the size of a pea. Direct examination by the use of an open speculum and a good light will complete the picture. This last procedure is essential to a proper

rectal examination and should never be omitted.

Treatment at this stage is relatively simple and decidedly satisfactory. Divulsion of the anal sphincter to admit five or six fingers should be done slowly so as not to tear the tissues. The abscess is incised in the long axis of the gut, the incision extending from the mouth of the crypt toward the anal orifice. The mucosal flaps of the abscess are resected to insure adequate drainage and to prevent any tendency to secondary pocketing. Follow-up visits to maintain a relaxed sphincter and a freely draining wound until the entire cavity is filled with granulations, will cure the disease.

The subacute and chronic cryptitis forms the channel of origin of ischiorectal abscess and fistula. Granulations and scarring effectively seal the mouth of the crypt so that the process is forced to extend deeper into the anal ducts or glands. The abscess, now more properly a column, reaches well into and beyond the muscle coats of the anorectal canal, and when rupture eventually occurs, it is into the highly susceptible pararectal space. The secondary abscess so evolved may be in the immediate pararectal tissue or at almost any distance into the ischiorectal fossa. One of two things may happen at this stage: (1) rapid accumulation of an abscess with rupture to the outside and the formation of a complete rectal fistula, (2) walling-off of the secondary abscess in the ischiorectal space with irregular drainage either into the rectum, or, and as eventually does occur, the formation of secondary channels and further foci of abscess. The second is obviously the more complicated because the fistula so formed is complex and may even be multiple in type.

Continued reinfection within the virtually non-collapsible ischiorectal fossa sets up a vicious circle. The infecting agent is retained in the isolated gland structures in and about the origin of the fistular tract. The persistence of these same glands keeps open the original tract to the anal crypt

and therefore to continued fresh source of infectious material. The irregular channel becomes thickened by the repeated scarring and hyalinization, so that the healing process at best is slow and irregular. Pockets filled with chronic purulent debris form activating foci and are followed by secondary acute abscess formation.

The inadequacy of open drainage as a sole form of treatment for this complex picture is due to the non-collapsible character of the pathology and to the fact that the entire process is contained in a relatively rigid fossa. Excision of all source material, that is, of the entire tract, associated with wide drainage of the cavity, though apparently very radical, is the only complete cure for the disease.

Tuberculosis is the causative agent in approximately 10 per cent of ischiorectal abscess. Pulmonary tuberculosis can almost invariably be demonstrated by x-ray, and chest plates should be taken, if only for the protection of the surgeon, in all cases where there is a possibility of this disease. The patient with anal tuberculosis gives a story of repeated operations for abscess without success. Examination shows the granulations about the sinus to be puffy and rather watery in character. If such a patient has a chronic cough, look for tuberculosis as the cause of ischiorectal abscess. The fact must be borne in mind, however, that a chronic cough by no means indicates that the ischiorectal abscess must be tuberculous in origin. Surgery to be effective in this disease must completely remove all the granulomatous tissue.

Abscess of a pilonidal cyst will occasionally drain downward into an ischiorectal space. The recognition of the origin of this abscess and the line of the sinus is essential, for it would decidedly complicate an already complicated picture to open this abscess into the bowel. Complete excision of the pilonidal cyst and the tract is necessary to effect a cure.

Rectal diverticulitis is a rare cause of ischiorectal abscess. The mechanism in this instance is very similar to that of anal

cryptitis with abscess and rupture into the pararectal space. The depth and extent of the tract, however, modifies the treat-

ischiorectal abscess that enter the Post-Graduate Hospital rectal clinic have had previous unsatisfactory operations

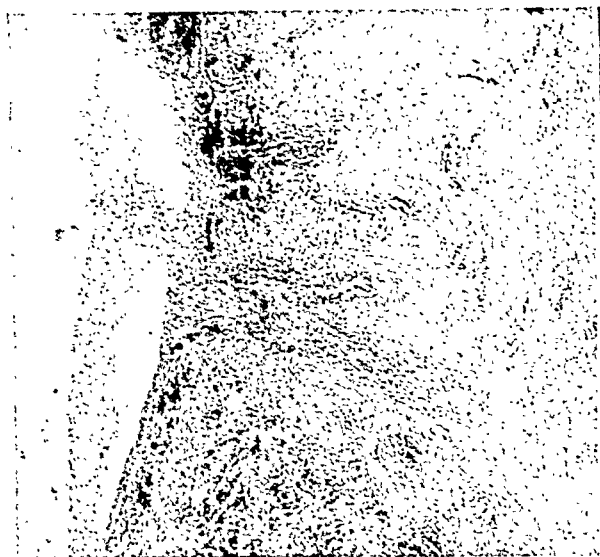


FIG. 1. Anal cryptitis forms the channel of origin of ischiorectal abscess and fistula. Note the exudative character of the disease, irregular scarring, and scattered persistent gland structure at the bottom of the crypt.

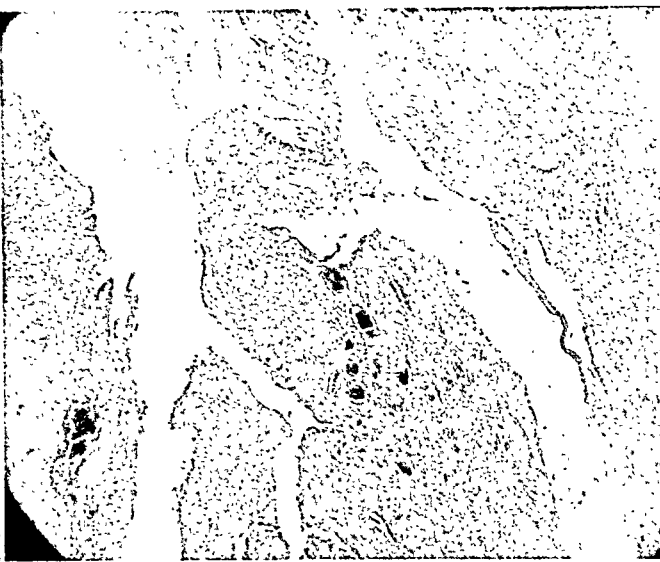


FIG. 2. The walls of the fistula are thickened by repeated scarring and hyalinization. The chronic purulent inflammatory disease is progressive and forms foci for secondary abscess and sinus formation.

ment, and the case must be treated as an intestinal fistula passing through the ischiorectal space.

Trauma as a cause of ischiorectal abscess is infrequent but nevertheless does occur. When treated immediately as a penetrating wound with adequate drainage, a cure may be expected without much difficulty.

Malignancy in the ischiorectal space will form an abscess, but the abscess obviously is of secondary importance and need not concern us in this discussion.

Anal infection as a focus of general toxic absorption comparable to disease of teeth, tonsils, appendix, or gall bladder, has received little consideration. Patients have lost their teeth, appendix and gall bladder in an attempt to relieve rheumatism and have failed because of undiscovered low grade anal cryptitis or even fistula. The routine medical examination should give the anorectal canal at least as much attention as the teeth and tonsils.

The treatment of ischiorectal abscess is not an office procedure. It must not be forgotten that 23 per cent of the cases of

which had served but to complicate the picture.

General anesthesia is to be preferred; gas oxygen or ethylene are adequate, and ether is rarely necessary. A small low spinal anesthesia gives excellent results, but the postoperative difficulties, particularly headache, complicate the picture; however, where a general anesthetic is counterindicated, parasacral block is preferable to the spinal.

Incision of the abscess completes the fistula. The extent and direction of the fistulous tract must be ascertained before further surgery is attempted, and this can best be done by the use of the flexible silver probe. If difficulty is encountered, the anal crypt involved can usually be located with ease, and the channel entered by a hooked probe from within the rectum. A complete divulsion of the anal sphincter is of course necessary to complete the above procedure. The fistula is grasped upon the probe and excised in its entirety by actual dissection. The sphincter muscles are preserved if possible, but if necessary one or even both

may be incised with little or no damage. If the incision through the sphincter is made at right angles to the muscle fibers, union will be reestablished without suture and without appreciable functional disturbance. The scar tissue forms an origin and insertion for the divided muscle. All tissue flaps and coverings of the wound must be widely resected so as to produce the effect of saucerization, and so that proper collapse may take place without secondary pocketing of infected material. A light iodoform gauze packing completes the procedure. Should pocketing occur at a later date, a secondary operation to complete the first must be performed.

Postoperative hospital care is simple, for the patient is comfortable and rapidly free of fever in spite of the radical surgery. After thirty-six hours an oil cathartic is given and in forty-eight hours the drains are removed. Regular low residue diet, mineral oil or agar-type cathartics and a daily sitz bath complete the routine.

After care of the rectal patient is prolonged, but to obtain a good result, it must be exacting. A well lubricated bougie is passed every day for the first week and three times a week thereafter until healing and epithelialization is complete. A small suppository of castor oil and balsam of Peru, equal parts, after each passage of the bougie, is very soothing to the patient. Periodic review is required for another six months to prevent a possible fibrous stenosis of the anus.

The more complicated fistulas of secondary horseshoe type must be dealt with as individual problems. One must keep in mind the warning of Miles, "it may be better to endure the discomfort of a discharging sinus rather than run the risk of permanent loss of control." This is particularly true when we realize that any form of treatment other than complete radical excision will do nothing but add to the complications.

Bacteriophage therapy is relatively untried in the treatment of pararectal inflam-

matory diseases. Cultures at operation usually show a mixed infection with *Bacillus colon acidilactici* and green streptococcus as the predominant organisms. A potent mixed bacteriophage is available and might well prove of considerable value as an adjunct to surgery, more particularly in the postoperative care of the more extensive wounds.

#### SUMMARY

A review of 100 cases of ischiorectal and pararectal abscess showed that 44 already had fistular formation upon entering the clinic and 23 had had one or more incomplete operations.

The origin and pathology of pararectal inflammatory disease is traced from the relatively simple acute cryptitis to the complex picture of ischiorectal abscess and fistula.

Three factors appear to complicate the picture; (1) delay on the part of the patient; (2) delay on the part of the doctor and (3) incomplete therapy.

The principal sources of infection of the ischiorectal space other than that outlined, are tuberculosis, pilonidal cyst with abscess, perforated rectal diverticulitis, trauma and malignancy.

The entire excision of the fistular tract with widely open drainage is advocated as the desired form of treatment. Bacteriophage therapy as an adjunct to surgery is suggested.

#### REFERENCES

- HIRSCHMAN, L. J. Focal infection of anal origin. *J. A. M. A.*, 97: 1609-1611, 1931.
- LOCKHART-MUMMERY, J. P. Fistula-in-ano. *Lancet*, 230: 657-660, 1936.
- MILES, W. E. Anorectal fistulae. *Post-Grad. Med. Jour.*, 12: 319-326, 1936.
- RANKIN, F. W., BARGEN, J. A., and BUIE, L. A. Anal Infections. The Colon, Rectum and Anus. Philadelphia, W. B. Saunders Co., 1932, pp. 580-608.
- TUCKER, C. C. and HELLWIG, C. A. Anal ducts: comparative and developmental histology. *Arch. Surg.*, 31: 521-530, 1935. *Histopathology of anal crypts. Surg., Gynec., and Obst.*, 58: 145-149, 1934.

# RUPTURE OF MUSCLES AND TENDONS\*

JOSEPH L. DECOURCY, M.D.

Attending Surgeon, Good Samaritan Hospital; Director, DeCourcy Clinic

CINCINNATI

UNLIKE fractures, which are an everyday occurrence, muscle and tendon ruptures are accidents which only occasionally come under the observation of the general practitioner. They may like fractures be direct, the effect of external trauma the impact of which is felt at the site of the muscle or tendon in question. But they are quite as frequently caused by a sudden poorly coordinated contraction of the muscle itself, or even of its antagonist, such as occurs when one is called upon suddenly to preserve his balance or escape a fall. Ruptures of this kind are known as indirect.

Since tendons form the insertion of muscles to their bony attachment, any disturbance of their physiology is linked necessarily with the muscles of which they are a part. When these tears sever the entire structure through its whole thickness, they are called complete ruptures; if they involve only a portion of it, they are partial ruptures.

Finally, we have to classify these ruptures into the traumatic and the so-called spontaneous or pathologic types, the latter being the result of a predisposition or of some pathologic condition such as arthritis, syphilis or senile degeneration. Occasionally a spontaneous rupture of a muscle or tendon occurs several months after some trauma that did not at the time produce this result. The patient may do nothing more than lift his hand or walk across the floor to bring on a pathologic rupture of one of these structures.

Symptoms vary with the extent and site of the rupture. The patient experiences a sudden pain, with loss or impairment of motion of the part. Swelling follows, with

continuous pain, worse on motion, sometimes up to the limit of endurance.

Because of the greater blood supply, ruptures in the substance of a muscle give rise to extensive hemorrhages. When the tear is in the tendon, signs of hemorrhage may be less but the possibility of necrosis is more.

At operation, if this is done promptly, the ends of the tendon are frequently found in a frayed condition and may be covered with minute bloody spots. A small blood clot or an extensive hematoma may be found occupying the space between the torn ends. The ends may have separated widely through the pull of the proximal severed portion. If operation is delayed, this separation increases and fibrous tissue begins to fill in the intervening space, in some cases even exhibiting the characteristics of calcification, especially where there has been extensive necrosis of tissue.

Among our most frequent tendon ruptures are those of the hand, the sites of predilection being the flexor of the middle finger in its middle phalanx, the center of the palm, and the extensor of the thumb in its second phalanx. A complete rupture is the most serious injury that can befall a tendon on either the palmar or the dorsal surface of the hand, and such ruptures are of very frequent occurrence. If not sutured promptly the tendon is liable to remain permanently severed, with corresponding loss of function through adhesions or formation of new fibrous tissue which prevents approximation.

## NECESSITY OF OPERATIVE MEASURES

Injured muscles should always be taken seriously in the early stages, because of the

\* From the Department of Surgery, DeCourcy Clinic.



inability of muscle tissue to effect true regeneration. The time element is important, owing to the functional damage that results from Nature's attempts at fibrous repair if the rupture is neglected. The blood clot between the ends organizes and results in a fibrosis. The scar tissue thus interposed between the muscular elements will not only cause contraction and shortening of the muscle, but will also produce pain on movement through compression of nerve filaments in the muscle plates as the result of fibromyositis. When the rupture is at a joint, this scar formation inhibits motion and binds together all those planes of fascia which should permit of gliding, which is the very essence of a tendon's proper function.

Generally speaking, I incline therefore to view that complete tears should always receive operative treatment. This is not always the case with partial ruptures, where there is a maintenance of continuity. In partial ruptures perfect restoration of function may often result with simple rest of the part, followed by gentle massage to stimulate the blood supply and gradual institution of passive and active movements.

If the rupture is complete, we must operate. Ordinarily, if no infection is present, we go ahead promptly with the repair of the injury. In presence of infection, however, we often deem it wiser to wait for traumatic inflammation to subside. We open up the rupture and remove the hematoma, but postpone the sutures for one or two weeks, or even longer if necessary; for attempts at repair while infection is active will jeopardize results. They may entail another operation at a later time, under worse conditions, because more tissue will have been sacrificed through suppuration. This postponement not only gives Nature a chance to clean up the infection but has the added potential advantage of establishing local immunity and thus encouraging the healing process after operation. In cases where we pursue this waiting course, it is desirable, in view of the certainty that the tendon ends will

retract more in the interim, to introduce a provisional suture in each of the cut ends to facilitate their identification later, thus obviating a long search for them when we are ready to repair them. The injured member is then placed at rest until the inflammatory condition subsides.

There is scarcely a muscle in the body that does not sometimes suffer a rupture. There is space here to consider only a few of the more important of these, with their appropriate treatment.

#### PROCEDURES

The common procedures in use for the repair of ruptured tendons are:

1. Tenorrhaphy, that is, the approximation and suture of the two severed ends of a tendon;
2. Reconstruction by lengthening (splitting or a silk thread);
3. Tenodesis, or implantation to a new point of attachment; and
4. Tendon grafting (transplantation).

Previous to the execution of any of these repair procedures, the original wound in the skin must be opened up completely and any infection present cleaned up. Extensive debridement and dissection of the tendon ends are important, especially if the rupture is in a finger or thumb. The skin incision must be ample in order to locate both ends of the severed tendon. In a rupture of the extensor pollicis longus it may be necessary to carry the incision far up toward the elbow before the proximal end is found, so strong is the pull of its attachment. Digital incisions must avoid the flexor surface of the finger and must not cross flexion creases at right angles. They should be made on the lateral margin of the fingers.

In all tendon operations great care must be taken to maintain the integrity of the vaginal ligaments of the tendon sheaths. Any blood clot or hematoma present must be thoroughly removed and aseptic conditions established.

*Tenorrhaphy.* When there is no important loss of substance, the two cut ends of the

tendon are brought together under conditions of strict asepsis and sutured together with some absorbent material, as chromic catgut, kangaroo tendon, or fine silk. Over a dozen different methods of tendon suture exist, all of them good. In digital work, the mattress suture is undoubtedly the strongest. Three such sutures are placed in each end, with the knots preferably tied and concealed between the two ends. Previous to suture, the ends, which are often severely fringed or frayed, must be cut clean with a razor to remove all traumatized tissue and to facilitate their approximation and coaptation.

Garlock<sup>1</sup> who has done important work on digital tendons, uses two fine straight needles on each end and carries his double line of braided silk mattress sutures obliquely through the entire thickness of the tendon, the two sutures interlacing with one another at every step and leaving a minimum amount of suture material exposed on the surface of the tendon until the needles finally come out through the cut surface at each end, two and two. When the knots are tied, they thus lie between the ends. They are drawn just tightly enough to take up the slack and to cause "buckling" of the tendon at the site of union. Garlock warns that when as a first aid procedure wounds at the junction of fingers and palm have been sutured too tightly without a preliminary debridement, a suppurative tenosynovitis rapidly develops, the flexor tendons slough and the fingers are left permanently crippled unless there is prompt secondary intervention.

After suture of a ruptured tendon of the hand, the member is placed at rest with dressings so arranged as to prevent tension; i.e., in a folded posture for the flexors and a straight position for the extensors. If both are ruptured, a neutral position is effected. It is then kept immobilized for seven to ten

days, after which active motion can be instituted.

*Tendon Lengthening.* Various means have been devised for lengthening a ruptured tendon when it cannot be made to reach its normal site. This is frequently necessary after retraction and healing in a crippling condition have occurred, a secondary tenorrhaphy being done to bridge the gap. In its simplest form, both ends of the tendon are cut horizontally at any desired distance from the end to a point halfway across the tendon. At this point the knife is carried back at right angles toward the end, cutting longitudinally and splitting the tendon almost to the end, leaving just enough of the tendon unsevered to make a sort of hinge. The free side of the split tendon of each end is then rotated 180° on this hinge as its axis until it faces and meets its mate of the other end, to which it is sutured, thus producing a lengthening of the tendon to any extent desired.

Many modifications of this method exist. Another method of lengthening often used is to insert a silk thread to fill up the gap. If the breach is not too long, Nature will soon clothe the silk with fibrous tissue and the tendon will have been reconstituted, often with good function.

*Tenodesis, or Implantation.* When other methods are not readily available, a severed tendon may be grafted onto a neighboring tendon or even to a bone. Thus, if one of the four tendons of the flexor sublimis or profundus digitorum is too seriously damaged for its ends to unite, its distal end may be attached to one of the neighboring sound tendons of the same muscle, since both have the same innervation. When the attachment is made to a bone, a hole is drilled in the latter to receive it.

*Tendon Transplantation.* Free grafts of tendons are indicated in cases where owing to excessive loss of substance no other method is applicable. These are usually homoplastic, taken from the Achilles tendon or the thigh; but they may occasionally be heteroplastic, from freshly amputated

<sup>1</sup>GARLOCK, JOHN H. Injuries of the tendons and nerves of the hand and wrist. Exhibit of drawings at the Ninth Annual Graduate Fortnight, illustrating his treatment. New York Academy of Medicine (Oct. 19-31) 1936.

limb of another individual, if such happens to be available at the time. Free or tubular grafts from the patient's forearm or abdomen are sometimes useful in finger injuries.

Meyer and Ransohoff<sup>2</sup> have recently been using with good success the celloidin tube method for reconstructing scarred digital tendons resulting from a neglected rupture. They use a two-stage operation:

1. The scarred tendon and its sheath are removed and a celloidin tube implanted in their place to bridge the gap temporarily, until the surrounding tissues adapt themselves to a normal position which the tube imposes.

2. The celloidin tube is then removed and the flexor sublimis of an adjacent finger is lengthened by a free tendon graft to reach the tip of the scarred finger. Each detail of the operation is based on an accurate knowledge of tendon anatomy and physiology and has for its essential principles the retention of the gliding function of the tendon and the restoration of normal physiologic tension to muscle and tendon.

Among ruptures of the larger muscles that the general practitioner meets in his practice, the commonest are those of the quadriceps and the long head of the biceps. In a quadriceps rupture the knee joint capsule also is liable to be ruptured. If such is the case, or if the belly of the muscle is rolled up into a hard ball, operation is imperative; for Nature cannot heal it properly. If it is neglected, there may be union, but not a satisfactory one, as it produces an elongation that will considerably weaken the quadriceps muscle.

After waiting a week or so for the inflammation to subside, a crescent-shaped incision is made on the internal border of the anterior aspect of the knee joint. The hematoma is removed by dissection and the different components of the muscle are identified, of which the rupture may involve all or only some. The ruptured capsule is sutured with No. 1 plain catgut. The

ruptured tendon ends are approximated and sutured with absorbable material. In some instances the suture of kangaroo tendon must be made fast to the patella, in which two holes are bored. The knee is immobilized for two weeks in a long Thomas splint elevated at an angle of 20°, at the end of which time passive and active motions are instituted. In some cases, in which the muscle is found rather friable, a flap of fascia from the thigh may have to be inserted into it. As the quadriceps muscle undergoes more rapid atrophy than any other in the body, the restoration of its continuity is of the greatest importance.

When the Achilles tendon is ruptured, it should be put at rest in a position of shortening. Under no conditions should a tight bandage ever be applied. Strapping and rubbing have been known to cause effusion and scar tissue over an extended area. Early surgical repair in complete or extensive tears saves much time and results in better function than attempts with palliative measures.

In ruptures of the head of the biceps, a large hard roll consisting of muscle belly is seen protruding on the anterior aspect of the arm above the elbow, with a furrow above it. The arm is weak but not helpless, since only one-half of the muscle is torn. Through a longitudinal slit, the muscle is reached, the hematoma removed, the frayed ends cut away, and an appropriate suture of chromic catgut placed. On account of the peculiar anatomic disposition of its origin, it may have to be sutured partly to the periosteum of the glenoid fossa and partly to the joint capsule, if the rupture is very close to the acromion attachment. The arm is immobilized for about three weeks in plaster in a slight degree of abduction of the upper arm and in supination of the forearm in maximum flexion. The presence of arthritis deformans is frequently a contributing factor in this type of rupture.

#### SOME POINTS OF TECHNIQUE

In operating upon ruptured tendons there are a few important rules that should

<sup>2</sup> MAYER, LEO. Ruptured tendons of the hand (Mayer-Ransohoff treatment). Exhibit of drawings at Ninth Annual Graduate Fortnight, illustrating his treatment. New York Academy of Medicine (Oct. 19-31) 1936.

invariably be borne in mind. Briefly stated, these are:

1. Never forget to look for a hematoma or to remove it including all traumatized tissue.

2. Do not suture a tendon under excessive tension; maintain exactly the normal amount of tension to enable the tendon to reach its place without pulling.

3. Do not forget to dissect back widely where tendons are extensively lacerated. This is especially important in ruptures in the hand, wrist and forearm.

4. Be sure that you have done a complete debridement of the skin wound before closure.

5. Take great care to maintain the integrity of the vaginal ligaments of the tendon sheaths.

6. In suturing, always have your alignment correct. This is as important in torn muscles as in broken bones. The line of traction must be mechanically faultless.

7. In making transplantations, do not expose the tendon for one unnecessary second.

8. Never wrap a tendon in gauze.

9. Never grasp its gliding surface with forceps.

10. Never make violent traction upon a tendon.

11. Be sure that the injured tendon is supplied with an abundance of well oxygenated blood.

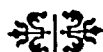
12. If there is much skin soiling, wait two weeks or more for the skin to heal before you operate. Infection may ruin your results.

#### SUMMARY

1. Since tendons form the insertion of muscles to their bony attachment, any disturbance of their physiology is linked necessarily with the muscles of which they are a part.

2. Among our most frequent tendon ruptures are those of the hand, the sites of predilection being the flexor of the middle finger in its middle phalanx, the center of the palm, and the extensor of the thumb in its second phalanx.

3. Symptoms and appropriate methods of care and treatment are discussed.



# PLASTER-OF-PARIS

HERBERT C. FETT, M.D., F.A.C.S.

Attending Orthopedic Surgeon, Long Island College, St. Charles, St. Mary's, Holy Name and St. Peter's Hospitals; Attending Surgeon in Charge of Fractures, Greenpoint Hospital

BROOKLYN

FOR many years plaster-of-Paris has been used as a means of fixation in the treatment of many orthopedic and surgical conditions. For a time, and perhaps still at present, many surgeons hesitate to use plaster-of-Paris dressings because of damage to tissue, which may result in permanent damage and disability to the patient. These difficulties can be avoided, providing a few general principles are observed and providing the physician or surgeon will give the individual case the careful attention, observation and follow-up which it deserves.

Plaster dressings are no more dangerous than other dressings, because plaster does not contract, but if indentations are made in a plaster dressing in the course of its application by the surgeon's or assistant's fingers, it is natural that pressure will result against the skin under the indentation. During the application of the dressing if wrinkles or foreign material are lying against the skin pressure sores are very apt to develop. Care during the application will avoid this complication. Often the use of talcum powder over the skin aids in preserving the skin.

Frequently one observes pressure sores over the heel. This is usually due to the fact that the surgeon allowed the cast to be placed against a hard surface before the plaster encasement had become sufficiently hardened. One of the first symptoms of which the patient complains, in cases of this kind, is a burning sensation in the region of the heel. One should never minimize any complaint which is made by a patient who has had a plaster-of-Paris dressing applied.

The bandages are very easily prepared and they can be kept over a long period of time providing they are kept in tin cans

(bread boxes) in a dry place. Plaster bandages which are made from crinoline plus a dental plaster-of-Paris are generally considered to be the best. The crinoline must be not less than thirty-two mesh and the plaster-of-Paris must be a very good grade of quick setting dental plaster. The crinoline is torn in the desired lengths and rolled in bandage forms. Most surgeons prefer a 2 inch bandage two yards long, a 3 inch bandage three yards long, a 4 inch bandage four yards long and so on up to 6 inches. These rolls then have two threads pulled from each side so that the threads will not fray when the bandage is being applied. Tight threads are apt to cause constriction and possibly pressure sores.

To make a satisfactory plaster-of-Paris bandage by hand the dental plaster must be very thoroughly rubbed into the meshes of the crinoline. If this is not carefully done it will be found that the dressing will consist of nothing more than wet crinoline.

Poorly made plaster-of-Paris bandages make it necessary to use more bandages for a dressing and prevent the surgeon from applying a neat, comfortable and satisfactory dressing. There are one or two very satisfactory machines available today for making plaster bandages, but most men who use a great deal of plaster feel that the handmade bandages are the best, providing the same individual always makes the bandages and that he or she give careful thought and time to the preparation and preservation of the plaster-of-Paris bandages. One difficulty which is frequently offered is that the individual who makes the bandages complains that the heel of the hand becomes very sore, which will necessitate a rest period occasionally.

Some men who use a great deal of plaster-of-Paris feel that it is quite neces-

sary to have each bandage wrapped in newspaper or a paper napkin. This is unnecessary because the bandages will keep just as well if they are placed gently and carefully in rows in a tin bread box and put in a dry place.

When the bandages are being used the assistant and the surgeon should avoid dropping any water on the bandages which are not being used. Drops of water on the dry plaster cause hard spots in the bandage which are troublesome and do not lend to the application of a satisfactory dressing.

The bandage should be carefully placed in a pail of clear warm water and allowed to remain there until all the bubbles cease coming from the bandage. This is an indication that the bandage is thoroughly saturated and ready for use. Bandages which are not thoroughly saturated should not be used as they tend to interfere with the application of a smooth dressing. It is best to use a deep pail so that the excess plaster which accumulates will not delay the saturation of the bandages which are being used. When considerable excess plaster is found in the bottom of the pail it is best to change the water or better to have a second pail always available. No salt or other chemical is necessary when one uses a quick setting plaster.

If an assistant or nurse is engaged in saturating the plaster bandages, the bandage is gently squeezed from both ends toward the middle so that the plaster is not squeezed from the bandage. The end of the bandage is then located and started before it is handed to the surgeon. Much time can be saved by this maneuver and this is quite important, particularly if the patient is under an anesthetic.

Training is necessary in the application of a plaster bandage, but because most people have a happy yen to retain their "mud-pie tendencies," plaster work seems to appeal to them. Nothing will develop the ability to apply plaster more readily than the frequent application of dressings. The dressing must be placed on the extremity in such a way that it is smooth and every layer carefully and thoroughly rubbed in. *The bandage must not be pulled*

*tight*, it should simply be rolled around and as it rolls it should be rubbed so that every layer is well smoothed off and the various layers well amalgamated. Indentations and irregularities should be avoided. Reinforcements may be used, but they should also be made of plaster-of-Paris.

Padding under a plaster-of-Paris dressing is used to protect the bony prominences. Some men prefer to use more than others. As one becomes more expert in his ability to use plaster-of-Paris it becomes less necessary to use much padding. The less padding the lighter the encasement and the more attractive the dressing.

Plaster-of-Paris dressings do not need to be heavy in order to afford the immobilization which is intended. Heavy plaster dressings are burdensome and certainly are not attractive. A light, smooth, well fitting plaster case is the work of a real artist.

Plaster-of-Paris bandages are very useful in the office of every physician and surgeon. The general practitioner finds considerable use for plaster-of-Paris in his office particularly in the treatment of fractures. Certainly much better immobilization can be obtained with a plaster splint than with the old-fashioned basswood splint. The application is just as simple and the moulded plaster-of-Paris splint affords much more relief to the patient.

#### SUMMARY

In this short paper an attempt is made to impress upon the medical profession the value of plaster-of-Paris as a form of immobilization. The article also stresses the fact that good plaster-of-Paris bandages are a definite requisite for satisfactory plaster work. It also stresses the fact that careful, thoughtful application of plaster is necessary in order to avoid complications. Some of the dangers are mentioned and instructions given to avoid these complications. The value of plaster as an adjunct in the office in the care of fractures or other joint conditions is also mentioned. The care and the making of the bandage are carefully described.

# USE OF ADHESIVE IN ORTHOPEDIC PRACTICE

H. H. WESCOTT, M.D., F.A.C.S.

Orthopedic Surgeon, Jefferson, Roanoke and Burrell Memorial Hospitals

ROANOKE, VIRGINIA

THE use of adhesive in the practice of orthopedic surgery differs in few respects from its use in the general practice of medicine and surgery. A review of the subject as discussed by Krida<sup>1</sup> and Willis,<sup>2</sup> together with a few additions, would seem relevant at this time.

The proper use of adhesive often saves time and expense to both the physician and the patient. It may be applied to act as an external splint to underlying injured tissues, or its sole purpose may be to act as a check or reminder and thereby prevent further damage to an injured member while repair is taking place.

In sprains and strains of the lower extremity, the use of adhesive around the forefoot or applied to the ankle usually results in the immediate rehabilitation of the individual. At the present time when the roentgenogram shows no fracture of the bones of the foot or ankle, the stirrup strapping is applied and immediate weight bearing is prescribed. The old ice bag treatment for twenty-four to forty-eight hours followed by rest in bed for several weeks is eliminated, as well as a prolonged period of physiotherapy. Waterproof adhesive, though it does not adapt itself to the various curves and contours as readily as the older form, allows the individual to continue without interruption their daily or weekly ablutions.

A word of caution seems necessary, even at this age, as to the application of adhesive to an extremity. So many of our confreres insist on encircling an extremity, either to anchor the stirrup strips or to depend on the circular strips as a support.

As swelling is always a complication due either to (1) an injury to the tissues, (2)

lack of use and venous stasis, or (3) to the dependent position of the part, it is quite as necessary to either split or bivalve such a dressing as to split or bivalve a cast following its application.

The Buck's extension, which has been used for many years, is being supplanted by skeleton traction. There are many instances in which adhesive traction will continue to be the method of choice because of its ease of applicability and the freedom resulting from its use. There are four points to be kept in mind when applying a Buck's extension to the leg:

1. The spreader should be of the same width as the heel;

2. A small square of gauze should be placed over both malleoli before the adhesive is applied;

3. The strips to anchor the stirrup strapping should encircle the leg obliquely to prevent interfering with the circulation; and

4. No strips should cross behind the Achilles tendon.

Adhesive is used in different ways by various individuals. Some may rely on it to approximate wound edges, treat ulcers and fractures, when another would have to resort to the use of plaster-of-Paris. In supracondylar fractures of the elbow, I have been using an adhesive lacing corset for eleven years (Fig. 1). Two partial cuffs are made depending on the size of the arm and forearm (Fig. 2). After reducing the fracture, a piece of sterile gauze is placed in the flexed elbow and the cuffs are applied. A small piece of tape is used to lace the cuffs together on both inner and outer aspects.

## CONCLUSIONS

The method recommends itself for the following reasons:

<sup>1</sup> KRIDA, A. *Am. Jour. Surg.*, 6: 430-432, 1929.

<sup>2</sup> PARK, W. W. *Northwest Med. Jour.*, 29: 229-230, 1930.

1. Pressure is distributed generally over the arm and forearm without constricting edges, such as results from the use of a single band of adhesive;

hyperextending fingers and hand. This is the first indication of a Volkmann's paralysis and should receive immediate attention by incising the fascia of the forearm;

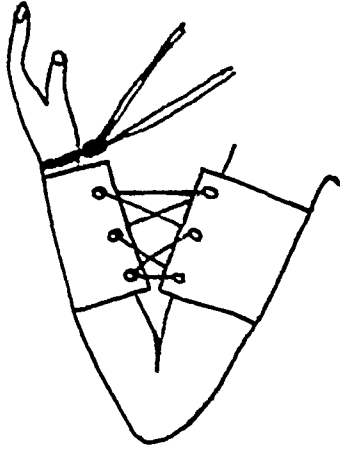


FIG. 1.

FIG. 1. Adhesive lacing corset applied in supracondylar fracture of elbow.

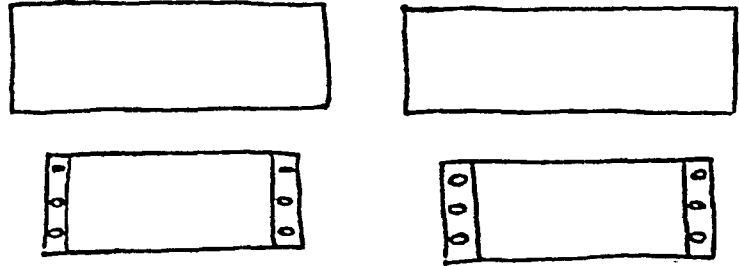


FIG. 2.

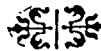
FIG. 2. Two partial cuffs made according to size of the arm and forearm.

2. Full supination is maintained;
3. There is no encircling bandage to disturb the circulation;
4. The radial pulse area is open and its condition may be noted without disturbing the bandage;
5. The test for impending Volkmann's ischemic contracture may be made by

6. The results of nerve injuries may be observed;

7. Active use of the arm in flexion (touching the fingers to the shoulder) may be instituted at once; and

8. The range of exercise may be increased by loosening the lacings as union progresses without disturbing the bandage.;





# USE OF UNPADDED PLASTER IN TREATMENT OF FRACTURES\*

CHARLES B. MABRY, M.D., F.A.C.S.

JACKSONVILLE, FLORIDA

PLASTER-of-Paris casts are used in the treatment of fractures to hold the fragments immobile, in apposition and maintain these fragments in the best possible alinement. The immobilization of fractures dates back to prehistoric times.

Magnuson<sup>1</sup> in a recent article has shown that for countless ages the Greeks and Romans as well as the Chinese held their fractures immobile by parchments, woods, resinous bandages, leather splints, hides and wax cloths. During the Renaissance many complicated traction devices were invented for the reduction of fractures and dislocations. Many of these reduction devices were a humane application of what formerly had been a torture stretching mechanicism. Frequently a pulley system was used an illustration of which is the Russell Traction<sup>2</sup> now perhaps one of the best methods of treating a fracture of the femur.

As it is not within the scope of this paper to discuss the methods of reduction of fractures nor their after care, our remarks are confined to a method of immobilization which we feel is superior to that commonly used and one which permits the patient to be more active as well as to shorten his period of convalescence. We make no claim for originality in this paper, but we have used non-padded casts for years and like them. We think the claims of Boehler<sup>3</sup> are not exaggerated, for our patients are up walking and mobile where other cases treated differently are at home with a "sick in bed" psychology.

Plaster-of-Paris bandage was first used for the immobilization of fractures by Mathysen in 1852. Its introduction was enthusiastically received. Fractures had previously been immobilized by huge thick casts that required assistance to move. We

can imagine the results which must have followed these heavy casts that stayed on too long or too short a time, and which had been applied too loosely or tightly. Many limbs must have been sacrificed. We know that casts became so general that frequently it was thought that a reduction was not necessary but that the cast was the all important feature of the treatment. Accumulated experience and time soon proved otherwise and the result has been the evolution of the reduction of fractures followed by the application of well padded casts as are now in general use. However, through this period some adventurers have found that plaster splints applied on the bare skin have been efficacious, but because of the constant fear of an ischemic myositis its use has been almost nil.

The technique of applying an unpadded cast<sup>4</sup> is simple: a 4 or 6 inch roll of plaster which has been prepared in the office or purchased and which has had the edges notched or raveled is immersed in tap water until all bubbling ceases. The plaster is then grasped in both hands, squeezed slightly together and removed from the water. The desired length of the splint is now layed out on a smooth flat table or board. The plaster bandage is then reversed on itself to the point of the beginning and this is repeated until the splint has eight to ten thicknesses. This forms a plaster splint. The splint must have no wrinkles and must be soppy. A 3 inch piece of quilting is now encircled around the leg just below the knee and is held in place by adhesive (Fig. 1). The splint is placed so that one end rests on the quilting posteriorly. The splint now follows down the posterior surface of the leg, over the heel and beyond the toes (Fig. 2). As the splint rounds the

\* Read before the Duval County Medical Society, Jacksonville, Fla., November 5, 1935.

heel it will form a fold, which is controlled by cutting the protruding flaps transversely and placing the proximal segments

covering (Figs. 3 and 4). Swelling within the cast can be largely prevented by elevation of the limb, either on a Thomas Splint,



FIG. 1. Quilting applied to leg.



FIG. 2. Posterior splint applied.

against the side of the heel, the remaining flap is then molded over the proximal one. Griswold<sup>5</sup> has shown that if the splint is sufficiently soppy and has no wrinkles it will lay smoothly on the leg. The circular bandage is now begun at the middle of the leg and continued over the heel and foot to the base of the dorsal surface of the toes and no further. It is important to let the bandage unroll and never draw it tight. It is equally important to have no wrinkles on the skin as they will later cause pressure ridges. If wrinkles try to form in the circular bandage let them be placed posteriorly on the plaster splint. The posterior splint protrudes beyond the toes and will allow support for the toes as well as prevent bumps and annoyances of the weight of bed

on pillows, or by suspension. The toes should be closely watched for the first forty-eight hours, if they show signs of circulatory constriction, that is cynosis, coldness, loss of sensation, or motion, the cast should be immediately split from end to end. This permits edema to occur without circulatory construction and at the same time allows the bony fragments to be held in their position of reduction. Caution as to care in edema cannot be too fully emphasized.

There is no preparation of the skin before the cast is applied. The leg should not be shaved nor greased because this defeats part of the purpose of the cast which is to adhere firmly to the skin and to closely mold over all bony prominences.

This type of cast is efficient on fractures of the foot and ankle. If the injury is above the ankle and not above the knee the cast

applied as follows; a pelvic stockinette is first applied. Triangle pads of quilting or felt are placed over the sacrum, buttocks,



FIG. 3. Splint encased by cast and heel incorporated.

should be made to extend from the groin to the toes. This is accomplished by cutting a piece of quilting 6 by 24 inches, rolling it tightly lengthwise and then wrapping it with a 2 inch muslin bandage. This is now placed in exactly the same position that the ring of the Thomas walking caliper would occupy, and held there with a sling by an assistant. A long posterior plaster splint is made as previously described and then applied to the bare skin posteriorly from the quilting roll to beyond the toes. An anterior splint may be likewise placed running to the base of the toes only, and the whole wrapped with circular unwrinkled plaster. The assistant always holds the cast with the palm of the hand or fingers, but never with the fingers indenting. The cast should never be tight. It must be constantly rubbed to expel air pockets. This makes the cast strong and hard, but light and thin. Five rolls of 6 inch plaster will make the entire leg cast. If the cast is made for a healing femur or pelvis it is

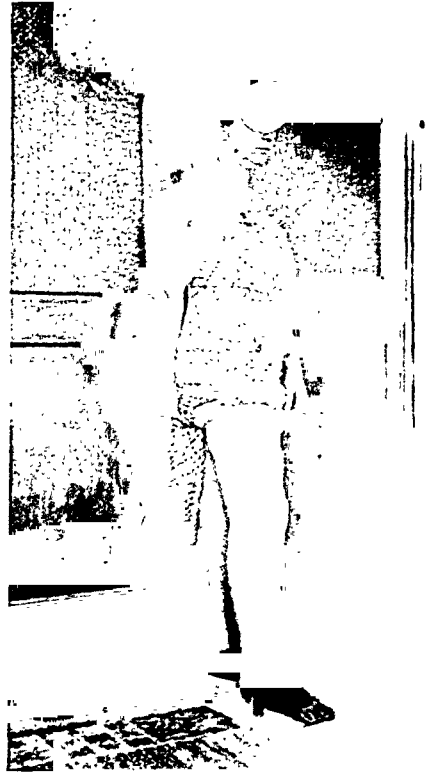


FIG. 4. Whole leg cast.

trochanters and anterior-superior spine areas and are held in place by figure of eight muslin bandages. The pelvic cast is then applied in the usual manner and extends to the costal margin. This being completed the leg cast previously described is applied and the two incorporated by plaster splints and circular casts (Fig. 5). The place of union must be well rubbed and made strong.

The patient can now walk. By incorporating certain appliances on the foot, weight may be borne on the afflicted limb without pain and with benefit (Fig. 6). The heels are "u" strips of iron  $\frac{3}{4}$  by  $\frac{1}{8}$  by 24 inches long. The bottom of the "u" admits one finger between the plaster and the iron heel. It should be applied the day following the application of the leg cast and must be in the weight-bearing axis of the tibia. A piece of large tubing or hose 4 inches long

over the "U" prevents slipping as well as noise and floor scratching. There have been many attempts to improve the iron "U"

or form of attempted immobilization splint holds the forearm half so well. We reduce a Colles's fracture by fixing the elbow in a belt

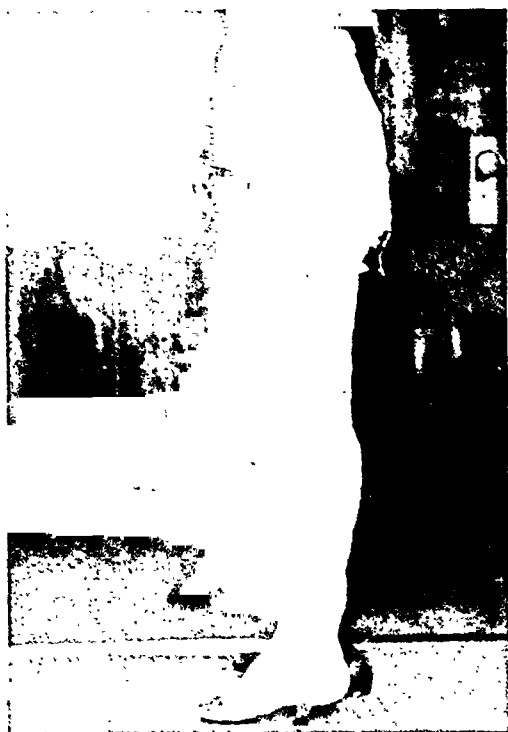


FIG. 5. Cast including pelvis.

by many complicated gadgets none of which seem to be as satisfactory as the plain Boehler "U" which is our choice. Another type of heel<sup>6</sup> is made by incorporating a rubber sponge in the boot heel, the disadvantage we have found with this is that first the cast being in contact with the ground may become damp and soft, which results in unequal pressure within the heel of the cast and discomfort to the patient. A third type of heel can be made by incorporating in the cast a bedroom slipper sole but this has the same disadvantage as the rubber sponge. A fourth heel is a wooden sole 3 by 6 inches, tapering in thickness from  $1\frac{1}{4}$  inch at the toes to  $\frac{3}{4}$  inch at the heel. This is incorporated in the sole of the boot by one plaster roll. It has been unsatisfactory, because the long flat sole limits the anterior-posterior roll in walking. The foot must be "toed out" to permit walking. Only one of our patients liked this heel.

Unpadded plaster is not confined in its scope to the lower extremity. No other

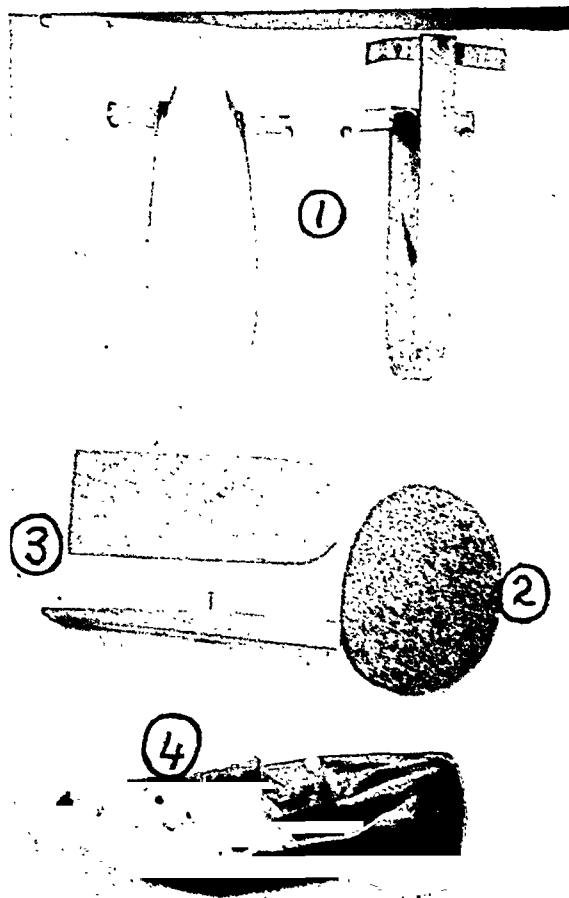


FIG. 6. Types of heels: (1) Boehler heel; (2) rubber sponge; (3) wedge board; (4) old bedroom slipper.

to a hook in the wall. An assistant makes ten minutes traction on the thumb and



FIG. 7. Forearm splint.

index finger and disregards the remainder of the hand. Manipulation is often unnecessary for traction frequently does the reduc-

ing. If the impaction is not reduced a slight manipulation while under this traction reduces the fracture. An unpadded splint



FIG. 8. Whole arm splint.

is now placed dorsally from 3 inches distal to the elbow to the metacarpophalangeal joint, also an anterior splint is applied. These may be wrapped by muslin or by plaster. The splint must exactly fit the forearm (Fig. 7) and the traction continued until the splints harden. If the splints are encircled with plaster a split is made on one side between splints, by this means the forearm is adequately immobilized and finger exercises are begun at once.

Most clean wounds do not need re-dressing, and do better if left alone. We frequently leave a sutured wound untouched for six or eight weeks until the cast is removed. Dressings over these wounds should not be thick, they should be held in place by the plaster splint which will not

infect them, but which will inhibit infection for it has been shown by Griswold that due to its alkalinity plaster is bacteriostatic to the usual pathogenic organisms, so an infection through a thin dressing will not occur.

If the fracture has been compounded, and edema or infection makes it necessary to cut a window, pressure should be applied over this window to prevent edema. This is adequately accomplished by a sterile sea or rubber sponge.

Another excellent arm cast is one which is made from a splint which extends dorsally from the knuckles over the dorsal surface of the forearm, around the elbow which is flexed to right angles and padded by three layers of silence cloth across the volar forearm to the second phalangeal joint. This is the so-called sugar tong splint described by Jewett.<sup>7</sup> The pronation-supination is governed by the location of the fracture and the hand placed in slightly dorsal flexion, the whole is wrapped by 3 inch muslin bandage which makes an excellent immobilization (Fig. 8). For upper arm fixation a "U" plaster splint is used which extends from the padded axilla over a padded elbow and thence up the lateral surface of the arm above the shoulder, the whole being wrapped in muslin and carried in a triangle sling (Figs. 9 and 10). This will not immobilize fractures involving the shoulder.

The advantages of non-padded plaster are many. The skin remains healthy because the sweat and excretory oils of the skin are absorbed by the plaster and cannot irritate the skin. Because of better immobilization the adjacent joints can be exercised thereby increasing circulation, preventing static edema and promoting healing. Our walking casts are leaving freely mobile joints immediately on removal which is something unheard of in a padded cast. Circulation of the legs remains good, because as the patient puts weight on the heel the muscles contract and act as a pump to the leg circulation. In walking the pump action empties and fills with each step. The bones are immobile

because of the molded cast. Sores never develop under the cast as is so frequently seen in padded casts with wadded cotton

3. Patients are mobile which adds to their comfort as well as hastens recovery.
4. This cast does not irritate the skin but



FIG. 9. Upper arm splint.



FIG. 10. Upper arm splint wrapped with muslin bandage.

and an oily irritated skin. The cast is removed easily and painlessly. Boehler has shown that the arm and leg hair desquamates every four to five weeks, so there is no hair pulling. The cast is split with a crowbill plaster knife or thin bladed cast cutter. The cutting is made very easy by wetting the plaster for twenty minutes at which time it cuts like thin cardboard.

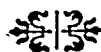
#### CONCLUSIONS

1. Unpadded plaster casts can be safely applied to the skin to secure better immobilization of extremities.
2. These casts are not difficult to apply and by their use a stronger but lighter cast is used.

absorbs the skin's excretory products and has an inhibiting action upon the growth of pyogenic bacteria.

#### REFERENCES

1. MAGNUSON, P. B. *Surg. Gynec. and Obst.*, 62: 276-286 (Feb.) 1936.
2. RUSSEL, R. H. Fractures of the femur. *Brit. Jour. Surg.*, 9: 491, 1923-1924.
3. BOEHLER, LORENZ. *Treatment of Fractures*, 4th English Edition translated by Ernest W. Hey Groves, Baltimore, Wm. Wood & Co., 1935.
4. SCHNEK, FRITZ. Vienna, Wilhelm Maudrich, 1932.
5. GRISWOLD, R. A. *Am. Jour. Surg.*, 32: 247-257 (May) 1936.
6. RECHTMAN, A. M. and SUBIN, H. *Am. Jour. Surg.*, 29: 149-151 (July) 1935.
7. JEWETT, E. L. *Am. Jour. Surg.*, 26: 336-339 (Nov.) 1934.



# MINOR SURGERY OF SPINE

ROBERT L. PRESTON, M.D.

Associate in Orthopedic Surgery, New York Post-Graduate Medical School, Columbia University

NEW YORK

FOR the purposes of this discussion, minor surgery of the spine is limited to those procedures which do not require especial technical skill.

Surgery of the spinal column presents peculiar difficulties. The spine is composed of twenty-nine movable segments and five fused segments. Each segment must carry the weight of the portion of the body above. The block-like segments of this weight-bearing mechanism are held in proper alinement by the coordinated pull of the powerful muscles which attach to all the segments. It must be borne in mind that the vertebral column consists of two parts, two vertical pillars of multiple segments; an anterior column composed of the vertebral bodies which is distinctly weight-bearing in function, and a posterior column composed of the neural arches whose function is multiple, i.e., protection for the cord and attachment for the spinal muscles and ligaments.<sup>1</sup> Except in cases of intrinsic spinal cord disease, the function of the spinal cord depends upon the maintenance of an adequate amount of space within the neural canal. Any abnormal change in the relationship of the movable vertebral segments, whether due to loss of coordination of the controlling musculature, or disease, fracture or congenital deformity of the vertebrae usually results in impaired spinal cord function or impaired function of the spinal nerves which leave the neural canal through the intervertebral foramina. The entire spinal column, with the exception of the tips of the spinous processes, is embedded in heavy musculature. It follows that because of the complicated structure and function of the spine along with its deep location and its proximity to vital nerve tissue, surgical approach is technically difficult and minor surgical procedures

are limited to (1) the introduction of needles into the subarachnoid and epidural spaces for diagnostic and therapeutic purposes and (2) the correction of uncomplicated fractures and deformities by manipulation and apparatus.

## SUBARACHNOID PUNCTURE

The spinal subarachnoid space is a potential sac surrounding the spinal cord, the size of which is determined by the volume of cerebrospinal fluid present. Above, this sac is continuous with the cranial subarachnoid space; below, it ends at the level of the lower border of the second sacral vertebra. The spinal subarachnoid space ends, therefore, at a considerably lower point than the spinal cord which terminates at the upper border of the second lumbar vertebra. To avoid puncturing the spinal cord, tapping of the subarachnoid space is done at a point below the termination of the spinal cord, in the interspace between the spinous processes of the third and fourth lumbar vertebrae. This interspace lies along the line connecting the crests of the ilia.

The position of the patient during the introduction of the needle is of extreme importance. The patient is placed on his side at the edge of the bed. The knees and head are drawn together so as to force the spine into hyperflexion, thereby widening the intervertebral spaces posteriorly. The lumbar region of the back must be exactly parallel to the edge of the bed and the transverse diameter of the back vertical. The needle may also be introduced with the patient sitting upright and bending forward to force the spine into acute flexion.

Having carefully placed the patient, an area a few inches in diameter, centering on the spine at the level of the crests of the

ilii, is painted with tincture of iodine and draped with sterile towels. The surgeon scrubs his hands and puts on rubber gloves. After palpating the depression between the spines of the third and fourth lumbar vertebrae, a small weal is made in the skin with 1 per cent novocaine solution. A short bevel spinal puncture needle is then inserted exactly in the midline, halfway between the spines of the third and fourth lumbar vertebrae. The needle is directed straight in at right angles to the skin in both longitudinal and transverse planes. In some cases the needle may strike the bony surface of the vertebra and it will be necessary to withdraw it part of the way and redirect the needle slightly upward toward the head. At a depth of about two inches the point of the needle may be felt to pass between the two vertebrae. As the dura is perforated a peculiar sensation of release of resistance will be appreciated. The stylet of the needle is withdrawn and if the subarachnoid space has been entered, spinal fluid will drip from the needle.

In cases of scoliosis with rotation of the vertebrae, it is necessary to direct the point of the needle laterally, away from the midline, toward the apex of the curve, the amount of lateral deviation of the needle depending upon the degree of spinal deformity.

*Puncture of the Subarachnoid Space at the Cisterna Magna.* Gilman and Kempt<sup>2</sup> describe an excellent technique for cisternal puncture.

A needle of larger gauge (16) that is not very flexible and has a small hilt is preferred, because it can be directed more accurately, a freer flow is insured, and the weight of the hilt will have less tendency to drag on the needle during the actual process of drainage. The needle should have a short, sharp bevel in order to allow entrance of the point without danger of the tip striking the medulla.

The patient is placed on the side, with the head on a pillow or pad of sufficient thickness to keep the head and the cervical and thoracic vertebrae in the same horizontal plane. The shoulders should be kept vertical and the head

slightly flexed; however, patients with opisthotonos are allowed to maintain the position of their heads but otherwise placed in the foregoing position. The position of the epistropheus is noted and the finger is placed in the suboccipital triangle (felt between the occiput and epistropheus as the depression in which the finger cannot be moved horizontally or vertically without leaving it). The position of the posterior border of the mastoid and its distance from the suboccipital triangle is estimated. This is the approximate distance the needle will have to be inserted in order to reach the cisterna magna.

Iodine is applied over the suboccipital triangle which has previously been clipped and shaved. A local anesthetic may first be instilled, although, when the puncture is to be repeated over a series of days, infiltration of the tissues frequently is not desirable because of the tendency to edema. With the patient's head facing straight forward so that there is no twist of the neck to the right or left, the needle, with the bevel directed caudally so as to avoid skiving tissues from the occiput into the lumen is inserted into the skin in the exact midline just at the upper border of the first spinous process. If the needle is started at a higher level one is apt to reach the cisterna with the needle pointed at the bridge of the nose, because the tissues and bony configuration will not prevent tilting. This direction gives 1 cm. less space for safety than if the needle is directed toward the normal hair line. If the needle is started in the exact midline at this point and directed at a point in the exact midline, at the usual place for the hairline, one can in many cases slowly and steadily carry the needle into the cisterna magna without changing its course. However, the needle usually strikes the base of the occiput first. In either event, when the needle has been passed through the skin and outer ligaments, the stylet is removed. One then gradually pushes the needle toward the cisterna, never allowing the tip to point below the eyebrows and attempting to keep it pointed as nearly as possible toward the hairline.

In order to insure a steady and gradual movement of the needle and to avert its going too far when it passes through the dura, it is best to hold the needle with both index fingers and thumbs, keeping the remaining fingers against the patient's neck and head for sup-



port. This assures a steady even pressure on the needle and prevents one from penetrating too deeply when the needle passes through the atlanto-occipital membrane. By this method the feel of passing through the dura (so essential when the stylet is left in) becomes less important, although it is still well to recognize it. As soon as the tip of the needle passes through the dura spinal fluid appears and with the larger needles even very purulent fluid appears at once.

The required depth is about 4 or 4.5 cm. Sometimes as low as 3 and as high as 6 cm.; however, frequently an unusually long occiput or an unusual muscular development makes the distance 7 cm. or even 8 cm.

#### EPIDURAL PUNCTURE

The epidural space extends the entire length of the spinal canal from the foramen magnum to the coccyx, beginning above where the thick cranial dura splits at the foramen magnum into its two functionally different layers. The external layer lines the spinal canal as the periosteum and thick fibrous covering of the ligaments of the spine. The inner layer becomes the true spinal dura and covers the cord as a sac. Between these two layers is a definite space, the epidural space, which contains semiliquid fat and a venous plexus. The true dura is continued as a cuff over the spinal nerves as they pass through the epidural space until just after the nerves leave the intervertebral foramina. For this reason<sup>3</sup> it is impossible for anesthetic solutions to block the spinal nerves within the epidural space. What actually happens is that a solution injected into the epidural space infiltrates the semiliquid fat surrounding the dura and spreads both superiorly and inferiorly. At each intervertebral foramen, some of the solution leaves the space along the perineural lymphatics surrounding the nerve trunks and anesthetizes these trunks producing in this manner a massive nerve trunk block comparable to a perfect paravertebral block.

When the spine is in acute flexion, there is negative pressure in the epidural space.<sup>4</sup> Odom<sup>5</sup> has devised a simple manometer to

use this fact as the means of locating the space. The short bevel lumbar puncture needle is introduced in the same place and in the same manner as for subarachnoid puncture. As soon as the manometer indicates negative pressure, 35 to 50 c.c., depending on the height of anesthesia desired, of 2 per cent novocaine are injected into the epidural space. A period of fifteen or twenty minutes must be allowed to elapse for the diffusion of the anesthetic solution before operating.

*Caudal Epidural Puncture.* Epidural anesthesia for caudal block is performed by depositing the anesthetic solution through the sacral hiatus into the caudal canal. The patient is placed in a prone position and the sacral area prepared surgically and draped with sterile towels. The caudal needle should enter the skin through the triangular shaped depressed area bounded by the two sacral cornua and the protuberance in the median line at the distal end of the sacrum. After a wheal has been raised<sup>5</sup> with 1 per cent procaine, the skin over the sacrum is immobilized with the left hand and the point of the needle, already attached to the syringe, is passed into the sacral hiatus with the bevel of the needle against the bone. The anesthetist rests the hand which holds the syringe on the patient's buttock so that, should the patient move, the anesthetist's hand will be raised and the needle will follow the hand rather than the hand following the needle and probably break the needle. The first part of the procedure is performed with a short needle. After the short needle has been introduced into the caudal canal and after 2 or 3 c.c. of a 1 per cent solution of procaine have been injected, the needle is withdrawn and another needle, with its stylet in place, is introduced. This needle must be so inserted that its bevel will be on the rough surface of the bone if it is to be advanced easily into the caudal canal. Its point should be inserted no farther cephalad than a line between the second sacral foramina. Higher insertion of the needle may result in subdural injection, for

the tip of the dural sac may be pierced by the caudal needle. If the ordinary amount of solution, 30 c.c., is injected into the caudal canal, thirty minutes will be required to produce anesthesia suitable for most urological, gynecological and proctological procedures.

#### TREATMENT OF FRACTURES AND DISLOCATIONS WITHOUT NEUROLOGICAL COMPLICATIONS

Fractures and dislocations of the spine with neurological complications are major surgical problems and do not come within the scope of this paper. Compression fractures of the bodies of the vertebrae are difficult to reduce. They usually produce a narrowing of the anterior border of one or more vertebral bodies in the dorso-lumbar region. If they can be treated within twenty-four hours after the injury, most of the wedging of the body can usually be overcome by careful manipulation under general anesthesia. The patient lies prone on the canvas sling of the Albee table or is placed between two tables in such a way that the pelvic and pectoral girdles are supported, and the trunk sags anteriorly. This forces the spine into hyperextension and reduces the deformity of the vertebral body. A plaster-of-Paris body cast is applied over a liberal amount of sheet wadding and moulded to maintain the hyperextension of the spine. The patient remains in bed for eight weeks and wears the body cast for twelve weeks. If roentgenograms show evidence of solid union, all support may then be discarded. Usually it is necessary to apply a Taylor spinal brace for another few months.

If the patient is first seen several days after the injury it is usually impossible to reduce the deformity by manipulation and the patient is put to bed on a Bradford frame which is bent in such a way as to force the spine into hyperextension. A body cast is applied after eight weeks, which is moulded to maintain the hyperextension of the spine. The future treatment is the same as that of the manipulated cases.

Fractures of the transverse and spinous processes do not present difficulties. Union rarely occurs in the transverse processes. A body cast is usually applied for a few weeks which is removed as soon as the patient is able to move about without pain or spasm of the back muscles.

Patients with fractures of the lamina and pedicles are placed in bed for a period of eight to ten weeks, after which a body cast or brace is applied and they are permitted to get about. The amount of activity these patients are allowed depends upon the evidence of repair of the fracture as seen in the x-ray pictures.

Fractures of the coccyx or sacrum seldom require more than a few weeks rest in bed. Occasionally a fractured coccyx must be excised.

Fracture of the cervical spine without neurological involvement requires rest in bed with traction applied to the chin and occiput by means of a Sayre halter. If the head of the bed is raised on blocks, so that the patient's body weight furnishes counter-traction, this apparatus gives satisfactory immobilization to the upper spine. In many cases it is possible to reduce a dislocation of the cervical spine (without neurological complications) by the same method. The patient remains in bed until all muscle spasm is relaxed and satisfactory evidence of repair can be seen on the x-ray pictures. After this, a brace or plaster-of-Paris body cast with an extension which fixes the chin, occiput and head is applied. The apparatus remains on until the roentgenograms show complete healing of the bone or, in the case of a dislocation of the cervical spine, until sufficient time has elapsed to permit firm healing of the ligaments, usually about eight to twelve weeks.

#### CORRECTION OF DEFORMITIES

The treatment of scoliosis, rotary-lateral deviation of the spine, varies with the age of the patient and the severity of the deformity. Mild degrees of lateral deviation at any age are best treated with exercise. Cases which become worse during this

treatment, especially if the patient is young and will continue to grow for many years, should have the principal curve fused. Before any surgery is done on these patients, the deformity should be corrected as much as possible. The patient is suspended from an overhead support with the Sayre halter. He is raised by this head suspension until only his toes touch the floor. Usually a marked improvement in the deformity results from this stretching. The patient then grasps the overhead support with the hand on the side of the concavity of the upper curve. This produces a further straightening of the spine. A body cast is now applied, which fixes the pelvic and pectoral girdles and includes the upper half of the elevated arm. When the cast is dry it is cut around the body at the level of the apex of the principal spinal curve. On the side of the concavity a turnbuckle is incorporated in the plaster cast at the anterior axillary line and another turnbuckle incorporated at the posterior axillary line. The patient is put to bed and the turnbuckles are gradually opened. In this way the upper and lower portions of the cast are separated on the side of the concavity and the spinal curve is straightened. The maximum correction is usually secured in about two weeks after which the spine is fused through a window in the cast, according to the method of Albee.

It is unsafe to use these methods for the correction of deformities resulting from tuberculosis of the spine. These patients are usually fused without correction as soon as the diagnosis can be made.

The inclusion of the treatment of uncomplicated fractures and deformities of the spine in a paper devoted to a discussion of

minor surgery might well be questioned. Strictly speaking, the complicated anatomical and physiological peculiarities of the spine serve to limit minor surgical procedures to the introduction of needles into the subarachnoid and epidural spaces for diagnostic and therapeutic purposes. However, it is felt that the increasing frequency of serious back injuries makes it imperative that the technique of treating uncomplicated fractures and deformities of the spine should be universally understood. For this reason it seemed desirable to add a short summary of the accepted manipulative methods of treatment of these conditions.

#### SUMMARY

Minor surgical procedures of the spine are limited to the introduction of needles into the subarachnoid and epidural spaces and the treatment of uncomplicated fractures and deformities. The technique of lumbar and cisternal subarachnoid puncture and lumbar and caudal epidural puncture is given in detail. The technique of treating uncomplicated deformities and fractures of the spine by manipulation, traction and casts is outlined.

#### REFERENCES

1. ALBEE, F. H. *Orthopedic and Reconstruction Surgery*. Philadelphia, W. B. Saunders Co., 1921, p. 396.
2. GILMAN, L. H. and KEMPT, G. F. Puncture of the cisterna magna. *Arch. Neurol. and Psychiat.*, 30: 1282-1286, 1933.
3. ODOM, C. B. Epidural anesthesia. *Am. Jour. Surg.*, 34: 547-558 (Dec.) 1936.
4. HELDT, T. J., and MOLONEY, J. C. Negative pressure in the epidural space. *Am. Jour. Med. Sc.*, 175: 371-376, 1928.
5. LUNDY, J. S. and TUOHY, E. B. Reginal anesthesia. *Am. Jour. Surg.*, 34: 511-518 (Dec.) 1936.



# FRACTURES OF COCCYX AND COCCYGODYNIA

JOHN C. McCAULEY, JR., M.D., F.A.C.S.

Instructor in Orthopedic Surgery, New York University College of Medicine; Associate Attending Orthopedic Surgeon, Bellevue Hospital

NEW YORK

THE coccyx is usually formed of four rudimentary vertebrae, the number may be increased to five or diminished to three.<sup>1</sup> Its contour is normally the continuation of the curve of the lower sacrum. The first segment resembles the last sacral vertebra with large rudimentary articular processes called cornua. The cornua project upward to articulate or approximate the cornua of the sacrum thus completing the foramen for the exit of the posterior division of the fifth sacral nerve. The articulation between the sacrum and coccyx is homologous with the intervertebral joints, with interposed fibrocartilage, in some instances the coccyx is freely movable on the sacrum and a synovial membrane is present. Such mobility is notably present during pregnancy.

The remaining segments are separated likewise by discs of fibrocartilage. In the adult male all the pieces become ossified together at a comparatively early period. At a more advanced age the coccyx often fuses with the sacrum, this is especially true in females.

Normally there are very limited movements forward and backward between the sacrum and the coccyx, and between the segments of the latter.

The coccyx gives attachment to the levator ani and coccygei muscles which together form a muscular diaphragm for support of the pelvic viscera. Posteriorly the lateral surfaces give rise to the inferior fibers of the gluteus maximus, and the sphincter ani externus takes its origin from the tip.

The anterior division of the fifth sacral nerve enters the pelvis between the sacrum and the coccyx, while that of the coccygeal nerve curves forward below the rudi-

mentary transverse process of the first segment.

The pudendal plexus is not sharply demarcated from the sacral plexus. It is usually formed by branches from the anterior divisions of the second and third sacral nerves, all of the anterior divisions of the fourth and fifth sacral, and the coccygeal nerves. Branches are distributed to the coccygeus, levator ani, sphincter ani externus, the muscles of the urogenital region, to the external genitalia, bladder, rectum and vagina; to the integument about the anus, between the anus and the coccyx, to the scrotum and labium majus. Communication is established with the perineal branch of the femoral cutaneous and the pelvic plexuses of the sympathetic.

The posterior divisions of the lower two sacral and coccygeal nerves unite in a loop formation to supply the skin over the coccyx.

We have then an anatomical foundation whose make up allows of various pathological possibilities, in the production of symptoms referable to the coccygeal region.

To injury from locally directed external forces little protection is offered by the overlying soft parts. From internal forces, injury is inevitable under certain conditions of malposition or fixed deformity, either to the coccyx or to the adjacent structures entering into the production of such forces.

Contusion, strain, sprain, fracture displacement, and irritative phenomena of nerve elements are the common resultant possibilities of trauma.

Morbid processes to which the component parts may be subject, other than trauma induced, make up a second group

of possibilities and third, a group of symptom complexuses not arising in the coccyx, but referred to it by reason of the complex nerve environment.

#### FRACTURES

Fractures of the coccyx compared to many other fractures are not common, but injuries to the tip of the spine do occur sufficiently often so that the average practitioner on more than one occasion is confronted with them and their problems for treatment.

Dislocations and displacements are included in this discussion as of equal importance with fracture. Lewin<sup>2</sup> has stressed dislocation as the most important of these clinical disturbances.

It is interesting to cite as a classical description the report of a case by Jobi Meekren<sup>3</sup> published in 1682. The patient, a woman, sat down suddenly on the closed seat of a toilet. Because of pain she could neither stand nor walk and was carried to bed. On the second day her pain became worse, Meekren was then called in consultation with her ordinary medical attendant. They suspected the trouble but she would not allow herself to be touched. During the following night her suffering became intolerable and the medical advisors were summoned early in the morning. Reduction of a dislocated coccyx was accomplished per rectum and she was instantly relieved of her symptoms.

*Injury by external forces* are usually direct in nature and of considerable violence, such as sitting forcibly on small or narrow objects, such as a child's block; kicks or blows received upon the tip of the spine; falls upon the buttocks, in the latter instance males are probably less susceptible to such trauma because of closer approximation of tuberosities of the ischia. The coccyx is driven forward in such instances and if the force is sufficient, displacement or fracture result. Fracture is more likely in those of advanced age.

It is conceivable that falls upon the contracted gluteal muscles, might result in

injury by muscular pull upon the coccyx as well as by direct violence. Cyriax<sup>4</sup> has reported a case in an individual who made a sudden effort to save himself from falling. He also calls attention to the importance of minor displacements in coccygodynia.

*Injury by Internal Forces.* Pressure against the coccyx from within may be the cause of damage to this structure. Pressure of the descending head during labor may result in fracture or dislocation. McCusker<sup>5</sup> comments on these injuries by saying they most often occur in patients with a history of previous injury to the tip of the spine, and that in healing the mobility was lost or that ankylosis occurred in a forward displaced attitude. Vermillion<sup>6</sup> reports 2 such cases of fracture, neither of whom complained of very much pain and the only treatment needed was the rest in bed incident to the confinement. He believes the severity of the symptoms does not depend upon the severity of the injury.

Jolly<sup>7</sup> reports a case of fracture dislocation in a young primipara. It was reduced following a forceps delivery with relief of the symptoms. Nine days later the lower segment of the coccyx was passed from the rectum. No further difficulty was experienced by the patient.

Gant<sup>8</sup> speaks of a case in which anterior displacement and ankylosis of the coccyx required excision before delivery could be effected. He also cites as possible causes of such injuries evacuation of enormous impacted fecal tumors or expulsion from the rectum of foreign bodies.

#### TREATMENT

In cases where displacement or fracture exists, and whether the former or the latter, is probably more dependent upon the anatomical age of the coccyx, than upon the type of trauma received, the findings of deformity, preternatural mobility, and possibly crepitus will be present. Immediate reduction is ordinarily easy and is best carried out by grasping the coccyx between the fore finger inserted in the rectum and the thumb over the posterior

surface. Anesthesia may be necessary. Splintage is practically impossible to apply with any effectiveness. In some cases maintenance of the reduction is difficult. Bed rest is necessary, four weeks being sufficient in the average case. The possibility of the fracture being compounded internally should be borne in mind. Badly fractured and displaced cases are best treated by excision. Persistent pain may be the aftermath, particularly in those cases where bony repair fails to take place, or where marked deformity obtains. In this class of case extirpation is unquestionably indicated. According to Da Costa<sup>9</sup> coccygodynia is seldom the result of fracture. The treatment of the less severe injuries will be discussed in the second part of this paper.

#### COCYGOODYNIA

Coccygodynia means literally pain in the coccyx. It is characteristically a paroxysmal aching or stabbing pain occurring spontaneously, and aggravated by any movement which brings into action the muscles attached to the coccyx, such as walking, sitting down or getting up from a chair, defecation and micturition.

Nott<sup>10</sup> was the first to describe the condition, when in 1844 he reported a case of neuralgia of the coccyx, requiring extirpation after all the articles in the *materia medica* had been exhausted. It is interesting to note that at operation he found the last segment of the coccyx to be carious and thinned out to a mere shell. Simpson<sup>11</sup> was the first to apply the term coccygodynia. In the first publication of his lectures he used the term coccyodynia.<sup>12</sup>

The condition was conceived originally to occur only in women, and was included in the nomenclature of Barnes<sup>13</sup> in his "Diseases of Women" in 1878. Jenks<sup>14</sup> stressed the frequency in women and thus its relationship to pelvic disorders, especially as a result of trauma to which the pelves of women alone are liable. He speaks of the analogy between coccygodynia, fissure of the anus, and vaginismus, in the

latter two instances, irritation in the region of the muscle causes painful contraction and he was convinced that in some cases of coccygodynia, the pain was caused in the same way.

The intervening and more recent text descriptions comment on the predominance in females, to which, in many instances have been added the adjectives neurotic or neurasthenic. Burnett<sup>15</sup> reviewed this descriptive attitude, but believe it to be grossly overrated. One must not lose sight however, of the possibility of this region being the outlet for manifestations of a functional disturbance. In coccygodynia a history of injury is the rule, rather than the exception, so that it becomes quite necessary to investigate such a history, in that proper evaluation of the trauma can be made on a physical basis. It is in this type of case that operation and removal of the coccyx has failed to cure the coccygodynia, and thus has rightfully placed a question mark after the indiscriminate application of this treatment. Hamill<sup>16</sup> reported such a case. He compares the pain to that of vaginismus, and believed that understanding not surgery was the best therapeutic approach.

Drueck<sup>17</sup> stated coccygodynia was most apt to occur in women with a history of functional nervous disease, and believed the muscle spasm comparable to vaginismus, and was the result of a mental reflex rather than from real hyperesthesia of the parts. He advised prolonged applications of heat and attention to the mental attitude and emotional status.

We have mentioned before, the possibility of coccygeal symptoms as part of a symptom complex of referred pain. This consideration is an extremely important one in coccygodynia. Kleckner<sup>18</sup> has suggested the name pseudo-coccygodynia as more appropriate to this type of case and advised thorough investigation for anorectal pathology. He also cited utero-adnexal disease in women and pathology of the prostate seminal vesicals and urethra in men as other possibilities. Gant<sup>8</sup> has men-

tioned excruciating pain from ulceration of the rectum, resulting from pressure of the gut against the tip of a malformed and forward displaced coccyx. Perforation as well as ulceration may result.

Disease of the coccyx itself, must be borne in mind, particularly tuberculosis. David<sup>19</sup> reported 2 cases and collected 25 others from the literature. His conclusions were that trauma played no significant role, generalized tuberculosis was conspicuously absent. The onset was insidious. Difficulty was experienced in locomotion but pain with defecation was absent. Sinuses were apt to form through the overlying skin less often into the rectum. Treatment by excision gave a good prognosis.

The author has removed the coccyx in 2 cases, in which, while there was no evidence of an infectious process, there was marked atrophy and softening of the bone structure. They were both in middle aged persons, one male and one female. The onset of symptoms in each instance followed real trauma. Both had received prolonged conservative treatment without profit. Both cases were cured by excision. One is inclined to wonder whether there may occur in the coccyx in certain cases a condition akin to traumatic osteoporosis.

In the initial stage of *tabes dorsalis*, rectal crises may present the symptom picture of coccygodynia.

#### TREATMENT

The first consideration is the proper evaluation from a careful history and thorough examination, which includes good x-ray pictures of the sacrococcygeal region, the existence or non-existence of any factor or factors which might be expected to produce such a symptom picture.

The indications for treatment in cases of disease, and significant deformities of the coccyx have received comment. That proper attention to, and correction of, abnormalities existing in adjacent or related structures has been discussed. That recognition of coccygodynia as a manifestation of functional nervous disease, has been stressed

as important, so that therapy may be applied to both ends of the spine in proper proportions.

We have left then to consider, a group of cases in which the disturbance resides in the coccyx itself and the treatment therefore is to be directed locally. These cases constitute the largest group, and they for the most part have symptoms resulting from trauma. The local findings are tenderness and increased pain on pressure or attempted movements of the coccyx. There is no significant deformity or evidence of disease.

In the more acute instances restriction of the activities which aggravate the pain must be enforced even to the point of rest in bed. This is of particular value in early cases. Attention to the bowels so as to avoid straining at stool must be observed. Tight strapping of the buttocks together, preferably as part of a low back strapping may afford some relief.

The use of an inflated rubber ring, for all sitting activities is very helpful. The size of the ring is important. If the diameter is such that the gluteal muscles are put on a stretch, increased discomfort may result. It should be considerably wider than the distance between the midpoint on each buttock. It should be inflated sufficiently so that the weight is borne entirely by the structures resting on the perimeter of the ring. Its particular advantage and usefulness is obvious in thin individuals. The ring may be enclosed in a pillow cover for those using the ring in an office. Its use should be continued until after the disappearance of the symptoms.

Prolonged applications of heat are important. Hot sitz-baths, may be prescribed. Rectal irrigations are difficult for the patient to use effectively at home. Local elevation of temperature by diathermy is of value in most cases when used properly. Careful massage through the rectum is tolerated in some instances and is of real help.

Injection of alcohol was advocated by Yeomans<sup>20</sup> on the basis that following

trauma contracture occurred in the dense surrounding tissues with nerve compression. Ten to 20 minims of 80 per cent alcohol was injected at the most tender spot, inserting one finger into the rectum to avoid puncture of that structure. Usually several injections were made. Kleckner<sup>18</sup> advocated quinine and urea hydrochloride as an agent for injections. Excision is not indicated as an immediate form of treatment in this type of case.

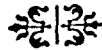
#### SUMMARY

The anatomy of the coccyx is reviewed, and considered from the standpoint of injury and as the site of coccygodynia. Fractures and dislocations, both from external and internal forces are discussed with their treatment.

Comments are made upon the various etiological possibilities of coccygodynia. Those cases resulting from trauma are considered most important and the treatment outlined in some detail.

#### REFERENCES

1. GRAY. *Anatomy of The Human Body*. Ed. 21. Phila., Lea and Febiger, 1924.
2. LEWIN, P. Coccyx, its derangements and their treatment. *Surg. Gynec. and Obst.*, 45: 705 (Nov.) 1927.
3. MEEKREN, JOBI A. *Observationes medico-chirurgicae ex Belgico in latinum translatae ab Abrahamo Blasio Amsterdam, Henrici & Viduae, Theodori Boom 1682.*
4. CYRIAX, E. F. Minor displacements of the coccyx. *Glasgow Med. Jour.*, 98: 98 (Aug.) 1922.
5. McCUSKER, H. Injuries of the coccyx. *Rhode Island Med. Jour.*, 17: 77 (May) 1934.
6. VERMILLION, E. L. Injuries to the coccyx. *Jour. Kansas Med. Soc.*, 30: 217 (July) 1929.
7. JOLLY, W. J. Fracture of coccyx and passage of the segment per anum. *Med. Record*, p. 762 (Dec. 7) 1887.
8. GANT, S. G. *Diseases of the Rectum, Anus and Colon*. Phila., W. B. Saunders Co., 1923. Vol. 1, chap. IX, p. 160.
9. DA COSTA, J. C. *Modern Surgery*. Ed. 9. Phila., W. B. Saunders Co., 1925.
10. NOTT, J. C. Facts illustrative of the practical importance of a knowledge of the anatomy and physiology of the nervous system. *New Orleans Med. Jour.*, 1: 57 (May) 1844.
11. SIMPSON, SIR JAMES Y. Ed. by Alexander R. Simpson. *Clinical Lectures on Diseases of Women*. New York, 1872.
12. SIMPSON, SIR JAMES Y. *Clinical Lectures on Diseases of Women*. Phila., Blanchard & Lea, 1863, Lecture XVII, p. 209.
13. BARNES, ROBERT. *A Clinical History of the Medical and Surgical Diseases of Women*. Phila., H. C. Lea, 1878.
14. JENKS, E. W. A lecture on coccygodynia. *Med. Record of New York*, 17 (April 17) 1880.
15. BURNETT, S. G. *Med. Herald and Physic. Therap.*, 49: 287 (Aug.) 1930.
16. HAMILL, RALPH C. Coccygodynia. *Med. Cl. N. Am.*, 5: 37-44 (July) 1921.
17. DRUECK, CHAS. J. Coccygodynia. *Jour. Indiana Med. Assn.*, 19: 275 (July) 1926.
18. KLECKNER, M. S. Coccygodynia: the present day interpretation and treatment. *Tr. Am. Proc. Soc.*, 34: 100, 1933.
19. DAVID, V. C. Tuberculosis of the os coccygis. *J. A. M. A.*, 82: 21 (Jan. 5) 1924.
20. YOEMANS, F. C. Coccygodynia—a new method of treatment by injections of alcohol. *Med. Record*, (Aug. 22) 1914.





# FRACTURES OF RIBS

LESTER BREIDENBACH, M.D., F.A.C.S.

Instructor of Surgery, New York University College of Medicine; Assistant Surgeon, Bellevue Hospital; Associate Surgeon, Misericordia Hospital

NEW YORK CITY

THERE is no doubt that in the last twenty-five years the incidence as well as the seriousness of injuries is increasing tremendously. The impact of the forces are greater, possibly due to our greater speed in industry and travel. It is for this reason that fractures take such an important place in surgery to-day.

Fracture of the ribs may be the only injury sustained by an individual or it may be only a small part of the injuries sustained because of the usual multiplicity of injuries seen following automobile and industrial accidents. Where the rib fracture is the only injury and barring complications, then we are dealing with a so-called minor surgical condition or one that may be treated by office procedure.

## ANATOMY

Briefly in review each rib has a posterior or vertebral extremity and an anterior or sternal extremity, the posterior extremity consists of a head, neck and tubercle. This is followed by a shaft, which is thin and flat with external and internal surfaces. The internal surface is marked by a ridge which commences at the lower extremity of the head. Between this ridge and the lower border of the rib is the costal groove for the intercostal vessels and nerve. The ribs consist of highly vascular cancellous tissue encased in a thin layer of compact bone. At the anterior end of the ribs the costal cartilages attach and join the upper seven ribs to the sternum. The eighth, ninth, and tenth articulate with the lower border of the cartilage above; the eleventh and twelfth ribs have no anterior attachment. The ribs are palpable excepting in very stout persons. They are very elastic and this elasticity is enhanced by the attach-

ment of the costal cartilages. The first and second ribs are well protected by the clavicle. Likewise the eleventh and twelfth ribs are rarely if ever fractured because these two ribs, not being attached anteriorly, move away with any force which may be applied to them.

Fracture of the ribs by trauma seldom occurs in children with the exception of forces which actually crush the chest severely, well beyond the wide elastic limit of these young ribs and cartilages. Violent muscular spasm as occasionally seen in pertussis has at times fractured one or both first ribs. Most cases occur in middle life, about forty years of age, where the individual is most active and more exposed to injury. For this same reason the male predominates over the female by 4 to 1.

Direct violence from falls and blows, in which case the fracture is usually located at the point of contact of the force, is the most common exciting factor. Indirect violence as by compression usually allows the fracture or fractures to occur at the weakest point of the rib, just in front of the angle of the rib. I have seen a case in which the amorous embrace of a husky lover compressed the chest violently enough to fracture three ribs. Muscular violence is a more common cause of fractured rib than usually thought. It is commonly reported in tuberculosis resulting from violent coughing. There are over 66 cases in the literature of this type. Any rib may be broken by muscular violence and it occurs in multiple ribs and there are cases of bilateral occurrences. Muscular violence sufficient to cause fracture of the ribs has occurred in parturition, vomiting, sneezing, straining at stool and lifting heavy objects. Usually fracture of

the ribs following this trauma is a linear fracture without displacement and not easily seen on an x-ray picture. The case is treated as a "dry" pleurisy especially when the fracture occurs from coughing, as in a tuberculous patient. Sometime later the patient is radiographed again to note the condition of the lung process when the roentgenologist notes a definite callus at the site of the previous pain, more readily visible than the minute linear fracture easily missed in the earlier plate.

Fractures may be partial or complete. Most partial fractures occur by muscular spasm either in children or adults. If the muscular spasm is very violent complete fracture occurs and at times even displacement. All other forces direct or indirect cause complete fractures. Fractures may be single or multiple involving many ribs or more than one fracture in a single rib. Crushing injuries not invariably cause bilateral, multiple fractures.

The first, second, eleventh and twelfth ribs are rarely fractured; but in the first and second, most of these have occurred by muscular violence as a result of coughing. In the third and tenth ribs the involvement is usually at points from the midaxillary line forward, where the ribs are most exposed to direct blows. In compression the bending of the ribs occurs to the breaking point usually the weakest point or just in front of the angle of the rib. Displacement occurs depending on the length of time that the force is applied so that we get overriding of the fracture ends or vertical displacement of the fragments. By the fact that the ribs are protected by the intercostal muscles and that the periosteum may not be broken on both the anterior and posterior surfaces of the ribs, displacement is not great.

As in all other fractures, so in fractures of the ribs compounding may occur, either through the skin or through the parietal pleura. Compounding through the skin is not often encountered, but compounding through the parietal pleura or into the lung is more common. Compounding through

the skin occurs when the impacting object is sharp enough to lacerate the skin. Compounding inward occurs by the force of the impact continuing long enough to actually push the fractured end of the rib into the parietal pleura and into the lung.

The complications that may arise from fracture of the ribs are often very serious and may easily lead to death. They may be listed as follows:

1. Pneumothorax, simple or valvular type causing tension pneumothorax;
2. Hemopneumothorax;
3. Subcutaneous emphysema;
4. Mediastinal emphysema;
5. Paralytic ileus;
6. Lung abscess;
7. Intercostal nerve and blood vessel injury;
8. Hemoptysis;
9. Pneumonia.

The symptomatology of rib fractures usually leads to the diagnosis. A history of trauma is always given unless the patient is unconscious. He tells you that he fell against some object hitting his chest against the object, or that his chest was crushed, or a history of severe cough, sneeze or hearty laugh may be given. Immediately following these traumas the patient experiences severe pain in the chest or calls it a stitch in the side. The pain is severe, lancinating and definitely increased by deep breathing. The patient very often holds the injured side with his hands and bends his body toward that side. At times he points to the one localized area of tenderness.

In order to examine the chest to determine the location and number of ribs fractured, palpation is of greatest aid. A localized area of tenderness with or without crepitus usually points to the site of fracture or fractures. An excellent way to elicit this is to put pressure on the chest wall with one hand anteriorly and one hand posteriorly. The patient will usually point to the point of greatest pain.

In the fracture resulting from muscular violence, after coughing, sneezing, laugh-

ing, etc., pain occurs very suddenly during these acts and is manifested by a sudden onset of severe pain, and since this type of

easily determine if it is progressive or localized.

Paralytic ileus as a symptom comes on



FIG. 1. Adhesive beyond mid line anteriorly and posteriorly.



FIG. 2. Adhesive completely encircling chest.

fracture often occurs in cases of tuberculosis, the inference is that the patient developed a pleurisy which would account for the same type of pain.

The symptoms and signs associated with the complications of rib fractures are usually easily picked up on examination. The degree of surgical shock is great, this alone makes one suspect that a complication has occurred. Hemoptysis occurs when the lung has been injured by the blow or by a piercing rib. However, it is not uncommon to discover a tuberculous lesion which may have been quiescent until the injury and trauma to the chest wall without laceration of the lung cause hemoptysis due to the diseased lung. Hemothorax, pneumothorax and hemopneumothorax in addition to the marked shock show severe dyspnea as well as the physical signs that go with these conditions. Subcutaneous emphysema can easily be felt and by observation one can

usually after twenty-four hours and one must suspect an intra-abdominal associated injury when this occurs. There are, however, a few cases in which this complication was so severe that it led to death and yet at autopsy no other lesion than fractured ribs could be found.

After the clinical diagnosis is made, an x-ray picture is necessary to confirm the condition as well as to add some information as to the chest contents. However, it must be remembered that not infrequently roentgenogram of the chest fails to bring out the fracture. This is unfortunate as there are many compensation insurance companies who feel that every fractured rib so diagnosed clinically should be confirmed by x-ray findings.

In fractures of the first ribs unilateral or bilateral the fracture is most often picked up three to four weeks after its occurrence because at this time enough callus has

been thrown out to show the point of fracture.

The differential diagnosis rests between a dry pleurisy with its agonizing pain on inspiration and expiration. The history of trauma and eliciting crepitus clinches the diagnosis. In pleurisy there is usually no localized tenderness on palpation or by applying pressure to the chest.

Having once made the diagnosis the patient is very anxious for quick relief from his severe pain or "stitch" in the side. The treatment barring complications is usually ambulatory. Immobilization of the chest wall is attempted to limit the free excursion during inspiration and expiration. This is best accomplished by strapping the chest over its lower half. When properly applied, relief is almost instantaneous. The immobilization is left on for two weeks. The patient is usually comfortable and often, if his work is not too hard, may continue to work. At the end of two weeks the strapping is removed and usually all pain is gone but localized tenderness persists. The rib is not completely healed yet but there is some callus present as seen in the x-ray film. The chest is restrapped and this is left on for another two weeks. Now all immobilization may be removed. Callus is usually well formed and healing almost complete, although slight tenderness may persist. The patient has a slight amount of pain, usually lasting for a short period of time. Emphysema or hemoptysis are not contraindications to immobilization nor is pneumothorax. However, these symptoms require bed rest in addition to the immobilization.

The methods of immobilization of the chest are as follows:

1. Strapping with adhesive beginning at the lower costal margin and completely encircling the chest. The plaster is most often only applied from 2 inches beyond the midline posteriorly to 2 inches beyond the midline anteriorly on the affected side.

To apply the adhesive a hairy chest should be shaved. The patient extends the arm on the affected side and supports him-

self against the wall. The adhesive is applied in deep expirations, usually using three strips of adhesive 2 inches wide begin-



FIG. 3. Sam Browne plaster.

ning at the lower costal margin and going upwards on the chest.

2. Another excellent method is by the use of plaster-of-Paris and making a Sam Browne belt. Plaster strips 4 inches wide girdle the lower chest and are applied in expiration. An extension plaster strip is run over the shoulder, going from the girdle of plaster anteriorly over the shoulder to the girdle of plaster posteriorly. This immobilization is left in place for four weeks and then removed.

Sedatives may be necessary and if there is a cough, codein sulphate grain  $\frac{1}{4}$  every three to four hours, acts well.

The treatment of the complications usually require bed or hospitalization and therefore beyond the scope of this paper.

#### SUMMARY

The first and second ribs, although well protected, do sustain fractures by indirect violence, usually muscular. In children,

fracture of the ribs is rare, except for severe crushing injury. It may be a serious injury with many complications, and even lead to death. Immobilization by any one of the three means described, is the treatment of choice.

#### REFERENCES

- BALLOU, H. C. and FRANCIS, B. F. *Arch. Surg.*, 19: 1627, 1929.
- BISTALFI, S. *Radiol. Med.*, 17: 1255, 1930.
- BOHLER, L. *Treatment of Fractures*. Ed. 2 and Ed. 4.
- BONSON, G. *Brit. Med. Jour.*, 346 (March) 1928.
- BROWN, O. A. *Southwestern Med.*, 13: 445, 1929.
- BROWNING, C. C. *Am. Rev. Tuberc.*, 25: 571, 1932.
- CHRISTOPHER, F. *Ann. Surg.*, 90: 394, 1929.
- CONROIL, G. J. *Arch. Surg.*, 18: 394, 1929.
- DUNLAP, H. A. and KOLEU, M. *Lancet*, 1: 452, 1930.
- FRIEDL, E. *Roentgenpraxis*, 5: 881-882, 1933.
- FUNSTON, R. V. *Jour. Bone and Joint Surg.*, 13: 174, 1931.
- GOODLUFFE, ROBERT V. *Brit. Med. Jour.*, 153 (Jan.) 1929.
- HAMMON, ROLAND. *Jour. Bone and Joint Surg.*, 17: 233-234, 1935.
- HARVEY, JOSEPH L. *J. A. M. A.*, 94: 21, 1930.
- HAWSON, CARL R. *Am. Rev. Tuberc.*, 30: 566, 1934.
- MEYER, PAUL. *Deutsch. Zeitschr. f. Chir.*, 244: 395, 1935.
- MONEY, R. S. *Med. Jour. Australia*, 16: 440, 1929.
- PITTAWA, H. F. *Roentgenpraxis*, 4: 1011, 1932.
- RICHARDSON, ERIC C. *J. A. M. A.*, 106: 1543 (May) 1936.
- SCUDDER, CHARLES. *Treatment of Fractures*, Ed. 9.
- SPEED, KELLOGG. *Text Book of Fractures and Dislocations*, Ed. 3.
- SPYRAPOULOS, CHARLES. *Chirurg*, 3: 1052, 1931.
- TIEGEL, MAX. *Zentralbl. f. Chir.*, 58: 1264, 1931.
- WAUGH, R. L. *Jour. Bone and Joint Surg.*, 17: 1067, 1935.
- WELDON, R. P. *Ind. Med. Gazette*, 65: 330, 1930.



# PATHOLOGY AND TREATMENT OF GANGLION\*

RALPH H. DE ORSAY, M.D., PAUL M. MECRAY, JR., M.D., AND L. KRAEER FERGUSON, M.D.

Instructor in Surgery, University of Pennsylvania      Voluntary Assistant, Surgical Out-Patient Department, Hospital of the University of Pennsylvania

Associate in Surgery, University of Pennsylvania

## PHILADELPHIA

**G**ANGLION is one of the troublesome lesions met in a minor surgical practice. Historically, it has been known since the time of Hippocrates, who is said to have referred to ganglion as "mucoid flesh." From that time until the eighteen hundreds very little was written on the subject. Between 1847 and 1893 various hypotheses were presented. Retention cysts arising from the subsynovial membrane, crypts and follicles were classified as "mucinous tumors." Ganglia were also referred to as synovial dermoids and serous cysts. Others considered them of neoplastic origin. Vogt,<sup>1</sup> in 1881, suggested that they arose from bursa. In the latter part of the nineteenth century Ledderhöse advanced the theory that they arose by cystic degeneration from the connective tissue around a joint or a tendon sheath. In 1928, Carp and Stout<sup>2</sup> made a review of the literature and careful microscopic studies, concluding that a ganglion was produced by the mucinous degeneration of connective tissue in or attached to capsules of joints or tendon sheaths. In 1932, King,<sup>3</sup> of the University of Melbourne, suggested a theory of proliferation of connective tissue with the accumulation of excessive extracellular secretion of mucinous material and the formation of cavity. He concluded that the process is not primarily a degeneration of cellular structures but is a secretion with the formation of a pseudo joint cavity in specialized connective tissue.

A ganglion may be defined as a cystic benign tumor, filled with a mucoid material usually surrounded by a thin wall and occurring in the region of the capsule and connective tissue of joints and tendon

sheaths. In accordance with other writers, we find a greater occurrence of the tumor mass in the second, third and fourth decades of life, the majority of patients being of slight build. The reason for this has never been explained fully. It is also evident that there is a sharp decline of the incidence after the fourth decade of life and that such cysts are of comparative rarity in old age. The fact that the greatest number of cases occur in early active life, when trauma is most likely, may have a definite bearing on the cause. In our series of 50 cases, 19 patients definitely gave trauma as the cause; 29 were unable to name any specific etiologic agent. Only 2 were certain that trauma had not occurred. The majority of cases listing trauma state that it is associated with a twisting motion. Such an example is well illustrated in the case of a seventeen year old boy who developed a typical ganglion of the dorsum of the wrist following repeated lifting of heavy milk cans from a loading platform into a truck. A girl of twenty-one years had a ganglion of the same type due to a strain from playing tennis. Another gave the cause as the repeated lifting of heavy ledgers. The wringing out of wet clothes was given by several housewives as the probable cause. The pressure of the knee against a machine while pushing down a lever with the foot was the cause of a ganglion on the lateral aspect of the knee. A ganglion developed on the dorsum of the foot following the painful trauma of kicking a chair. Another occurred on the flexor surface of the fifth finger from bowling. A street car employee had his hand jammed between a plank and a piece of steel; ten

\* From the Surgical Out-Patient Department, Hospital of the University of Pennsylvania.

days later a swelling appeared at the base of the thumb on the flexor surface. From these examples it may be assumed that

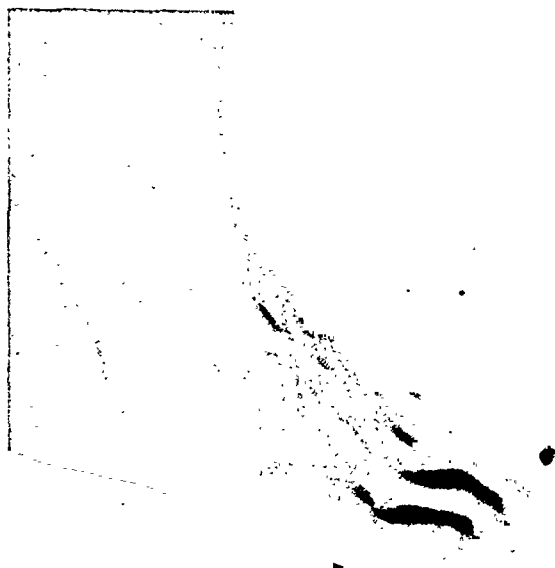


FIG. 1. Ganglion of dorsum of foot which developed after a truck wheel had passed over the patient's foot. Cure followed excision.

trauma plays a part in the etiology of ganglia (Fig. 1). It is likewise true that strains and traumata occur to the tendon sheaths and joints without the formation of ganglia.

King believes that there is also a constitutional factor which plays an important role, for the ganglion is sometimes seen to regress as the general condition of the patient changes, without traumatic rupture of the mass.

#### PATHOLOGY

Because of the apparent inefficiency of the treatment of ganglia we have been prompted to reexamine the pathology of this lesion. It is the hope that a clearer understanding of the mechanism of the production of these lesions may lead to improved methods of therapy.

On gross examination the excised ganglia have, in our experience, varied in size from a tiny globule, 0.5 cm. in diameter, to a mass which measured 6 by 3 by 2.5 cm. They may be solid, or show varying degrees

of cyst formation. If multiloculated, the loculi may be of approximately the same size or there may be one large and several smaller ones. The contents are usually colorless. The consistency varies; rarely it may be fluid but more commonly it has the viscosity of glairy mucus.

For some years it has been the teaching of one of us that ganglia arise from degenerations of mesoblastic tissue with the formation first of solid masses which gradually become cystic. This process of evolution has the support of King<sup>3</sup> who has recently presented a paper in which he divides the development of ganglia into three stages. We present photomicrographs which depict his classification (Figs. 2, 3 and 4). His idea is that a metaplasia occurs in the specialized connective tissue around joints and tendon sheaths. Spheroidal cells develop in scattered closely packed groups. These cells are seen to possess a vacuolated protoplasm and a central round nucleus. Around the periphery of the grouped spheroidal cells, there is a gradual change into spindle cells. As the droplets accumulate in the vacuolated spheroidal cells, this secretion is discharged into the tissues between them (stage I). The process continues until the extracellular collection of the secretion separates the cells more widely. Finally enough of the mucinous material has been secreted to fill a large portion between the cells and now has the appearance of a small cavity (stage II).

Numerous groups of spheroidal cells carry on this process until there are multiple cystic formations. These gradually merge with each other due to atrophy of the intercystic septa, giving rise to larger spaces. As the process ceases, the cells become less spheroidal in appearance and finally return to their original spindle shape (stage III). In all these developmental stages of the cyst there are always associated a number of smaller cysts and a few scattered nests of spheroidal cells in close proximity.

It must be confessed that one of the senior pathologists, on reviewing our sec-

tions, stated that it took some imagination to follow the transition between stage II and stage III. He tersely remarked that

number, and the reticulum, shown by Laidlow's silver stain,<sup>5</sup> persists until complete cyst formation. There is evidence of

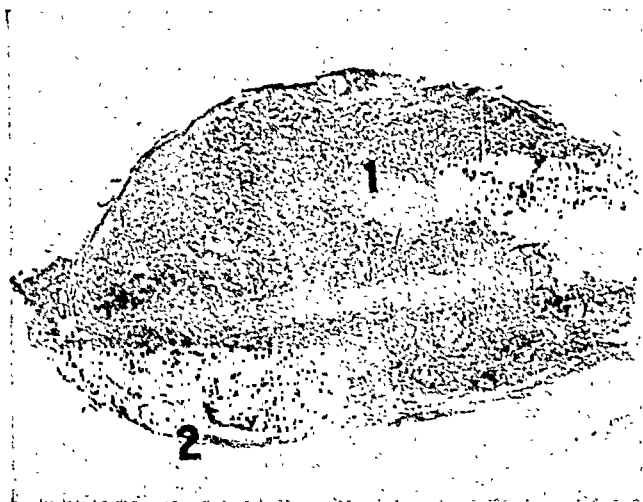


FIG. 2. Ganglion removed from over flexor tendon sheath in hand, at metacarpophalangeal joint; pathologically classed as stage I or very early ganglion (King's classification). It shows one area of early cyst formation (1) and numerous involved nerves (2) at the periphery.



FIG. 3. Ganglion removed from extensor tendon sheath at wrist; pathologically classed as stage II or moderately well developed ganglion (King's classification).

"imagination is a bad thing for a pathologist to have." The coalescence of the small cysts to form larger ones is apparently definite, however (Fig. 5).

By the use of differential staining, several points of both clinical and pathological interest have arisen in this study. It has generally been believed by previous writers<sup>2</sup> that ganglia have a mucinous content, and indeed it does give some of the chemical reactions of this ill-defined group of glycoproteins. However, by the use of Mayer's mucicarmin stain, we have been able to show that the contents of ganglia are probably myxoid rather than mucinous. This differentiation becomes of importance when it is viewed in the light of King's theory that the content of ganglia is a secretion rather than a degeneration. We are prone to question this since, with the exception of the eye, there are but few places in the body where myxoid tissue occurs as a secretion. Thus in summary the writers view the process as a specific degeneration of the collagen fibres, as is shown by Mallory's phosphotungstic acid stain.<sup>4</sup> The elastica are diminished in

hyaline change around the areas undergoing myxoid degeneration. Whether these two processes are going on concurrently or whether the myxoid tissue arises in the



FIG. 4. Ganglion removed from the extensor tendon sheath at the wrist; pathologically classed as stage III or fully developed ganglion (King's classification). There were several areas at the periphery which showed early degenerative change.

hyalinized areas is not clear. Ziehl-Neelsen-Gabbet stain<sup>6</sup> for tubercle bacilli gave no indication of the presence of these organisms.

All three of our cases which were classed as early (stage I) gave definite evidence of chronic inflammation. This was shown by round cell infiltration (Fig. 6) and in one



section by an occasional polymorphonuclear leucocyte. Marked perivascular fibrosis was seen in these sections. It is

It may occur in other connective tissues. In this group of cases are 3 in which the ganglion had no connection with either



FIG. 5. Photomicrograph showing coalescence of small cysts to form larger ones (same case as Fig. 2).

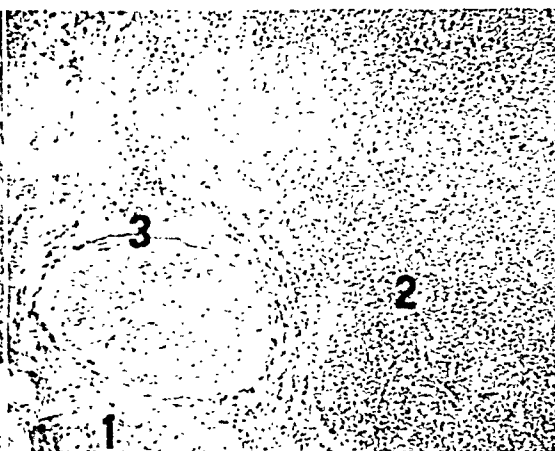


FIG. 6. Early ganglion showing fibrosis of the vessels (1), round cell infiltration (2) and degeneration of an involved nerve (3).

noteworthy that in that late ganglia (stage III) there was almost no chronic inflammation and in general there was less fibrosis in the walls of the vessels. Several of our sections contained portions of nerve tissue. In every case it showed degenerative change. It is probable that this may have accounted for the pain noted by these patients.

Most important clinically was the observation that in all save the very early cases there was noted degeneration at the periphery of the cysts. This was best demonstrated by the mucicarmin stain. At the outer margins, localized areas which had taken a pinkish stain could be seen. These were surrounded by apparently normal tissue. Such areas conveyed the impression that portions of degenerating tissue had been left behind in the excision of the ganglion. It is probable that these areas not excised may account for the reappearance of ganglia following excision. They suggest the necessity of a complete and fairly wide excision if recurrence is to be avoided.

In discussing the pathology of ganglion another observation should be pointed out. The degeneration of connective tissue to form ganglia is not found only in connection with joint tissue and tendon sheaths.

joint or tendon. Two of them appeared on the dorsum of the distal phalanx of the thumb and one involved the peroneal nerve (Fig. 7).

#### SYMPTOMS

The most prominent symptom is the presence of a mass. This is probably because the most frequent site of ganglion is the dorsum of the wrist and other extensor surfaces. The swellings may be uniform in size or may consist of a multilocular mass. Occasionally there may be a decrease in size, later followed by enlargement. Cysts such as are found on the palm of the hand are not evident on the surface.

Pain is variable. This may be described, when present, as usually dull in character, more or less persistent and most marked upon motion of the neighboring joint and tendons. Ganglia occurring on the flexor sheaths over the metacarpophalangeal joints are painful when pressed upon by a hard object (Fig. 8). Weakness of the wrist, finger and toe may be a complaint, when ganglia are present.

Depending on its content, the ganglion may be tense and firm to palpation or soft and fluctuant. It may be bony hard when

the wall is thick and the contents a semi-solid gel. Others may be fluctuant, especially when multilocular. They are usually

ruptured the area is massaged so that the gelatinous contents may be dispersed and absorbed in the surrounding subcutaneous



FIG. 7. Ganglion of dorsum of distal phalanx of thumb developing in connective tissue which has no relation joint or tendon sheath.

attached to the deeper underlying structures and may be felt to move on motion of the neighboring joint or with the involved tendon sheath.

#### TREATMENT

The indications for treatment of ganglia are three in number: (1) the desire of the patient to remove the unsightly mass produced by the ganglion, (2) the relief of the feeling of weakness of the part often noted when a ganglion is present, and (3) relief of the pain or soreness which frequently accompanies the presence of ganglion.

Three methods have been used in our hands in treating ganglion; they are rupture, aspiration and excision.

**Rupture.** Rupture with dispersion of the contents of the ganglion has been regarded as the most conservative method of treatment. The rupture is accomplished by striking the ganglion sharply with a heavy object, usually a book. This method is applicable only to ganglia which may be made prominent, such as those on the dorsum of the wrist (Figs. 9 and 10). No anesthesia is required. After the ganglion is

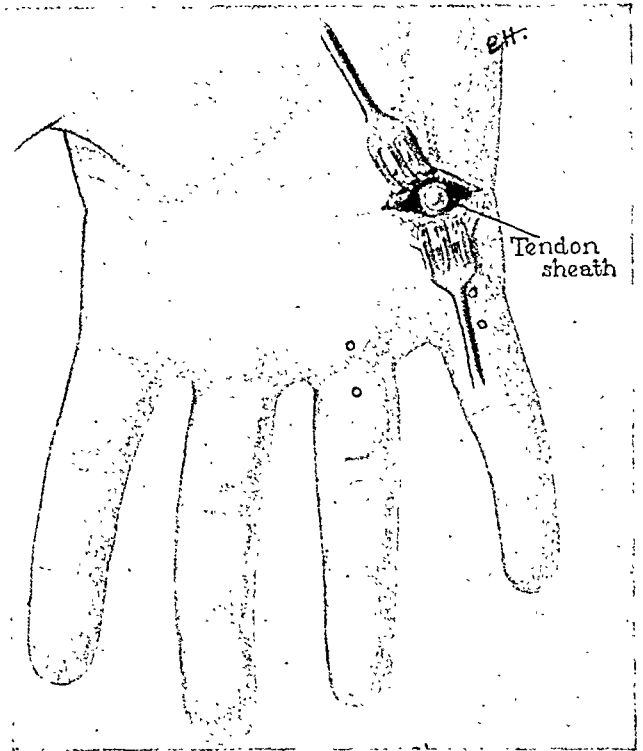


FIG. 8. Ganglion of the flexor tendon sheath in the hand. Small circles represent most frequent sites of these lesions. Excision is the only method of treatment.

tissues. We have carried out this form of treatment with the knowledge that recurrence may take place, but since a cure is obtainable by simple rupture in at least one-half of the cases, it seemed this conservative treatment was worth at least one trial. Our experience with 32 cases showed a permanent cure without recurrence in 16, or 50 per cent. In 16 cases recurrence took place, making the failure percentage equal to cure percentage by this method of treatment. In 10 other cases we were unable to produce rupture and excision was performed.

**Aspiration.** The treatment by aspiration of the ganglion contents has been disappointing (Fig. 11). In many cases the contents of the ganglion is of such a firm jelly-like consistency that aspiration has been unsuccessful. In other cases the multilocular character of the ganglion has made it difficult to be certain that the con-

tents were entirely evacuated even though some of the gelatinous material could be removed. We have avoided the injection of

*Excision.* The most successful method of treatment in our hands has been careful dissection and excision of the ganglion.



FIG. 9. Ganglion of dorsum of the wrist showing ganglion made prominent by flexion of the wrist in preparation for rupture and dispersment.

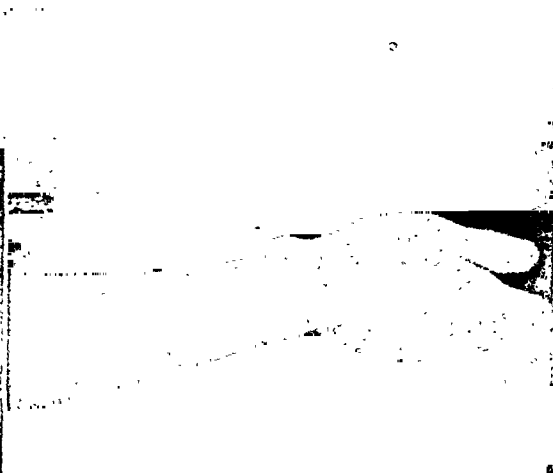


FIG. 10. Ganglion of palmar surface of wrist. Ganglia in this location cannot be treated by rupture.

irritants as has been recommended by some writers because of the uncertainty of the injection. Seven cases have been treated by simple aspiration under local anesthesia



FIG. 11. Large ganglion of palmar surface of finger treated unsuccessfully by aspiration with later excision and cure.

and of these only one case was permanently cured. For this reason we have discontinued this form of treatment.

Whenever possible, a tourniquet is used to produce a bloodless field. This insures a more rapid and accurate dissection. The operation may be performed under local infiltration anesthesia of 1 per cent procain hydrochloride. With strict aseptic precautions and retraction to keep the sides of the wound on tension, the ganglion is separated from the surrounding tissue by blunt and sharp dissection. At its base it is wise to excise a fairly generous amount of the surrounding tissue. This we feel is the best insurance against recurrence.

If the capsule of the joint or a tendon sheath is opened, it is carefully closed with interrupted sutures of fine catgut or silk. After the closure of any dead space in the same manner, the skin is sutured with a vertical mattress stitch of black silk thread. A firm compression bandage is applied and the part splinted when possible. The patient is ambulatory throughout his treatment. With this type of therapy we operated upon 18 patients with complete removal and cure of 15, or 83.3 per cent. There was a recurrence in 3 cases, or 16.7 per cent. Of the recurrences 2 were cured by subsequent rupture, one by excision.

## SUMMARY

1. A study of ganglia is presented with the review of 50 personally treated cases. We are inclined to the belief that trauma is a definite etiologic agent.

2. From a pathological study we have been able to confirm King's idea that these masses appear first as a solid tumor mass with later formation of small cysts which progress to the formation of larger cysts by the disappearance of the intercystic septa.

## ANALYSIS OF CASES

| Age in Years | Male | Female | Total |
|--------------|------|--------|-------|
| 11-20        | 7    | 8      | 15    |
| 21-30        | 8    | 13     | 21    |
| 31-40        | 3    | 3      | 6     |
| 41-50        | 2    | 2      | 4     |
| 51-60        | 0    | 1      | 1     |
| 61-70        | 2    | 1      | 3     |
|              | 22   | 28     | 50    |

## ANATOMICAL LOCATION OF GANGLIA

|                               |    |
|-------------------------------|----|
| Dorsum of wrist.....          | 29 |
| Palmar surface of finger..... | 8  |
| Flexor surface of wrist.....  | 3  |
| Dorsum of foot.....           | 2  |
| Dorsum of finger.....         | 2  |
| Dorsum of toe.....            | 2  |
| Lateral aspect of knee.....   | 3  |
| Popliteal space.....          | 1  |

3. Various staining methods have led us to believe that the contents of ganglia are myxoid rather than mucinous and therefore

## ANALYSIS OF TREATMENT

| Method          | Cases | Cures | Per Cent | Recur-<br>rences | Per Cent |
|-----------------|-------|-------|----------|------------------|----------|
| Rupture.....    | 32    | 16    | 50       | 16               | 50       |
| Aspiration..... | 7     | 1     | 14.3     | 6                | 85.7     |
| Excision.....   | 18    | 15    | 83.3     | 3                | 16.7     |

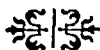
the process is one of degeneration of collagen fibres rather than a secretion of connective tissue cells as suggested by King.

4. Recurrence of ganglion following rupture or excision probably takes place due to a continuation of the degenerative process in tissues adjacent to the original ganglion.

5. By simple rupture and dispersion, a permanent cure can be expected in about 50 per cent of cases. By excision a cure can be expected in about 85 per cent of cases. Best results are obtained by a fairly wide excision of the tissues surrounding the ganglion in order to be sure that all the tissue undergoing myxoid degeneration be removed.

## REFERENCES

1. VOGT, PAUL. *Deutsche Chir.*, 64: 158, 1881.
2. CARP, L. and STOUT, A. P. *Surg., Gynec. and Obst.*, 47: 460-468, 1928.
3. KING, E. S. J. *Australia and New Zealand Jour. Surg.*, 1: 367-381, 1932.
4. MALLORY, A. M. and WRIGHT, J. H. *Pathological Technique*, Phila., W. B. Saunders, 1918, p. 71.
5. LAIDLAW, G. F. *Am. Jour. Path.*, 4: 239-247, 1929.
6. MALLORY, A. M. and WRIGHT, J. H. *Pathological Technique*, Phila., W. B. Saunders, 1918, p. 352.



# COLLES'S FRACTURE\*

ANDREW R. MACAUSLAND, M.D.

Clinical Professor of Orthopedics, Tufts Medical School; Orthopedic Surgeon, Carney Hospital

BOSTON

FROM a study of the many excellent articles that have been published on Colles's fracture, it may be concluded that its treatment is well understood. There also seems to be little doubt that the principles underlying reduction are appreciated and that the pitfalls of treatment are well in mind. Yet, in spite of this general knowledge of the handling of the fracture, the results, on the whole, are far from satisfactory, especially in elderly cases.

In the experience of this Clinic, a Colles's fracture is often seen that has not been completely reduced. In view of this tendency toward imperfect reduction, further emphasis must be placed upon proper handling of the fracture, to obtain full reduction, not partial reduction, of the deformity.

In the first place, this fracture should be reduced promptly. Since it is a fracture near a joint, it should be reduced completely. If deformity persists near joints, chronic changes soon appear. Older people often develop arthritic changes following a fracture, but in the presence of persisting deformity these changes with the resultant loss of function become greatly exaggerated.

In the ordinary Colles's fracture there is the well known silver-fork deformity. The lower radial fragment is displaced backward and also toward the radial side. In older patients the fragment is often comminuted. In some cases the tip of the ulna is broken off by the pull of the carpal ligament. If the ulnar tip is not fractured, then in any case the ulnar ligament is torn. For this reason, a point of tenderness often persists on the outer side of the wrist where reattachment of the ligaments is taking place, and such tenderness may be

present long after a well reduced fracture has healed.

The opinion is sometimes expressed that the fragments in a Colles's fracture are "impacted." It is to be noted, however, that there is no stability or fixation of the fragments. Within a week after the fracture the fragments loosen in the normal healing process.

There are other complicated forms of Colles's fracture where displacement is considerably more severe, as in the  $\tau$  fracture into the joint. In such cases the fragments may separate as much as  $\frac{3}{4}$  of an inch. Such complications are important when it comes to reduction measures.

In children the Colles's fracture is represented as a separation of the lower radial epiphysis with displacement backward.

Successful reduction of this fracture depends to a great extent upon an understanding of the anterior palmar tilt of the lower end of the radius. The axis of the plane of the wrist joint is about 15 to 20 degrees from the longitudinal axis of the radius. This change in plane is due to the curve of the radius and to the tilt of the joint surface. Oftentimes when the x-ray study of the fracture is made, the displacement of the lower radial fragment is seen to be very slight, that is, only a fraction of an inch, but the deformity in the angle of the joint may be a full 50 degrees. Thus, it is essential to appreciate the angle of deformity in a fracture near the wrist joint that has apparently only slight displacement.

One of the greatest errors made in handling Colles's fracture is that reduction is seldom sufficiently complete to restore the anterior tilt of the radial end. The orthopedic surgeon, the general surgeon, or the

\* From the MacAusland Orthopedic Clinic, Boston.

general practitioner pulls the wrist down by some particular method and considers reduction to be complete. It may, in fact, be

Reduction also must be accomplished early before any absorptive changes have taken place. If treatment is delayed, the

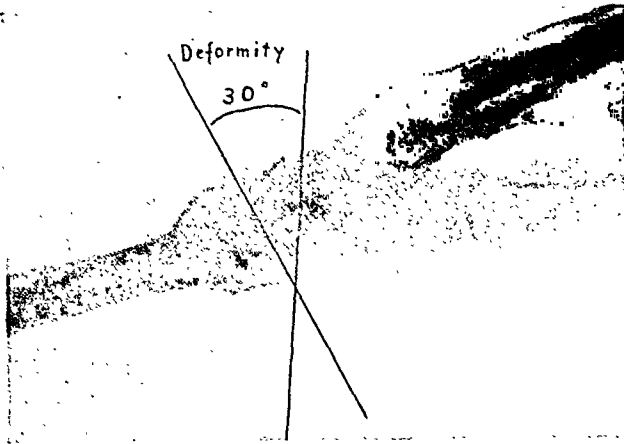


FIG. 1. Roentgenogram showing an incompletely reduced fracture with a 30 degree deformity.

close to perfect, even to within 10 degrees, and there is no backward displacement, but the end of the distal fragment is directly in line with a straight line along the radius.



FIG. 2. Roentgenogram showing a Colles's fracture with typical backward displacement and avulsion of the tip of the ulna.

The wrist joint following such partial reduction is weak, and symptoms tend to be prolonged (Fig. 1).

Attention must also be given in reduction to correcting radial displacement. Should the whole wrist be left displaced toward the thumb side, readjustment of the joint later will take much longer and prolong the symptoms.

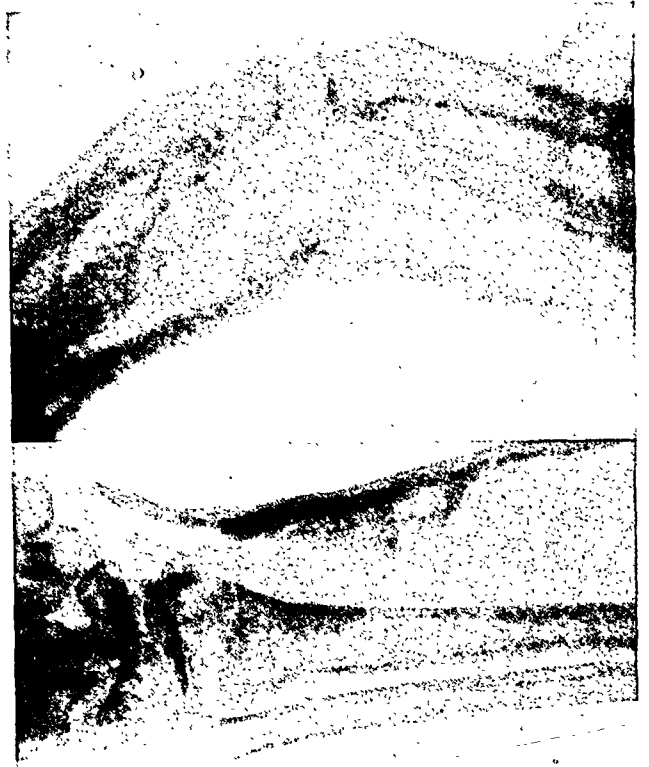


FIG. 3. Roentgenogram showing reduction of the Colles's fracture (Fig. 2) with restoration of the proper anterior tilt of the radial joint surface.

deformity becomes fixed and when an attempt is made to tilt the upper fragment back into position, the ends of the fragments will not fit together.

Reduction may be carried out under general or local anesthesia. Local anesthesia is entirely satisfactory if properly used. Not only the radial fracture cavity, but also the torn ulnar ligaments must be anesthetized, whether or not there is a fracture into the ulnar area. Otherwise, anesthesia will not be complete. Nerve block anesthesia of the brachial plexus is also very satisfactory.

The following maneuvers are carried out in reducing a Colles' fracture. (1) As in all fractures, the deformity is increased by pulling the wrist back, and the fragments are loosened; (2) the lower end of the radius is forced toward the ulnar side; and

(3) the radial fragment is pushed forward into position, letting the wrist fall into flexion. The wrist should never be jammed down in reducing the fracture; rather the operator, using his thumb on the lower end of the radius, can push it forward, giving that extra little push to bring the joint surface facing 15 to 20 degrees toward the palmar side. It is not sufficient simply to force wrist flexion to accomplish this third maneuver. Extra force must be used, and it is often the omission of this final push that causes an imperfect reduction (Figs. 2 and 3).

In the reduction of a fracture of the  $\tau$  type, attention is first directed to the correction of the main displacement. The wrist is pulled back to increase the deformity. When it has been well increased, the radial fragments are pushed together and then held tightly, and are brought forward in one mass. Usually these fractures are reduced without preventing spreading of the radial fragments, because so often the displacement appears to be slight. It is very important, however, to make sure that no separation exists between the fragments. If the main fractured surface is forced forward without holding the fragments together, the  $\tau$  fracture is under tension and the fragments spread. A spread joint means a damaged joint.

The treatment of the displacement of the lower radial epiphysis in the child is exactly the same as the treatment of the ordinary Colles's fracture in the adult. In these cases there is the danger of damaging the epiphyseal plate, which will interfere with growth. There is no way of controlling this danger except by perfect reduction.

In any fracture that is difficult to reduce, as for instance a fracture that is from two to four weeks old, a Thomas wrench may be used to help in breaking the fragments loose from callus and reducing them.

When the fracture has been reduced, the patient or nurse may hold it, without danger of redisplacement, while the plaster splint is being applied. Plaster-of-Paris

strips, reinforced at the wrist and non-padded, make a most satisfactory form of support. There are many types of splints on the market that may be used to fix the wrist, but in general they are not satisfactory. When a plaster casing is used, it is possible to mold the proper curve of the wrist. Care must be taken, if there is a great deal of swelling, to tighten the plaster casing as the swelling subsides. If this is not done, the wrist becomes loose in the plaster casing. An x-ray picture is taken a week to ten days after reduction.

The wrist is left in the plaster splint until union is pretty solid; a period of one month to five weeks is usually required. Meantime, the fingers are free for motion and massage may be used if swelling persists.

Colles's fracture is a simple fracture to reduce and there is little excuse for a poor result. There is no fracture that will give better results when completely reduced.

#### SUMMARY

The numerous unsatisfactory results of the handling of Colles's fracture, despite the general understanding of its treatment, leads the writer to direct attention to this fracture.

Imperfect reduction, due to the failure to restore the anterior palmar tilt of the lower end of the radius, is the cause of the majority of unsatisfactory results. Colles's fracture is a fracture near a joint, and if the deformity is only partially reduced, the wrist joint remains weak and chronic changes with a resultant loss of function develop.

Colles's fracture is a simple fracture to reduce and there is little excuse for a poor result. In reduction, the deformity is first increased by pulling the wrist back; then the lower end of the radius is forced toward the ulnar side to overcome the radial displacement; and finally, the radial fragment is pushed forward into position, letting the wrist fall into flexion.

# FIRST AID TREATMENT OF FRACTURE OF FEMUR AND HIP\*

JOHN H. MULHOLLAND, M.D., F.A.C.S.

Assistant Clinical Professor of Surgery, New York University College of Medicine; Assistant Attending Surgeon, Bellevue Hospital

NEW YORK

THE problem of first aid treatment for fracture of the femur and hip is principally the problem of transportation of the injured person. The leg must be protected and further injury prevented while the patient is being brought to the hospital. It is general knowledge that arrest of hemorrhage is essential and the relief of pain is highly desirable, but it is especially known to the fracture surgeon that proper transportation is, at least, equally important. Indeed the most effective measure for the relief of pain is the preparation of the patient for transport.

We need only refer to the work being done by the regional fracture committees to appreciate these facts. A broad study of fractures with the view of improving the treatment indicated that the first fifteen minutes after the accident was the danger period during which those perplexing and crippling complications occurred in extremity fractures. The skill and technical advances in treatment which were applied in the hospital could not overcome poor handling in the street. It is during this period that injury to the blood vessels, muscles, and nerves may be added to the already injured skeleton. Bancroft gruesomely describes "jackknifing" the patient to get him through a motor car door in overzealous attempts to rush him to a hospital. The ease with which compounding can occur under such circumstances is apparent. In the hip fractures to which the aged are subject, traumatic shock becomes the pressing problem when they are improperly transported. It was thought at one time that they had better not be treated until recovered from shock; now

we know that the greatest single factor in recovery from shock is splinting the fracture and the greatest single factor in the etiology of shock is motion at the site of fracture during transportation. Adequate immobilization by simple splinting or tying the legs together is impossible. To lift a patient for the purpose of moving him a few feet can cause irreparable damage.

That badly broken legs can be moved for long distances safely and with ease after the application of a simple device was demonstrated during the World War. At that time a modification of the Thomas splint by Keller permitted its easy use by stretcher bearers. Along with traction the method is known as a fixed traction method for transportation. Its use is strongly advocated by fracture committees throughout the country. The New York and Brooklyn regional committee with the cooperation of the Municipal Department of Hospitals has instituted a plan for instruction in emergency splinting methods which is in use in the city hospitals and many of the private hospitals in the region which the committee serves.

All the ambulances are equipped with first aid apparatus which is carefully specified. The equipment consists of a fracture box which contains the necessary bandages, straps, adhesive tape, rope, slings, and clips along with a reversible Keller-Thomas leg splint and a Murray-Jones arm splint. The arm splint may be used for fractured thighs in children. All the apparatus was described and used by Kennedy and his staff<sup>1</sup> at the Beekman

<sup>1</sup> Committee on the Treatment of Fractures, American College of Surgeons, Outline of the Treatment of Fractures, 1933.

\* From the Third (New York University) Surgical Division, Bellevue Hospital, New York.



Street Hospital. The box is kept filled by a system of exchanges where one nurse is responsible for the filling after use, and the

In so far as fractures of the hip and femoral shaft are concerned the instructions are as follows:

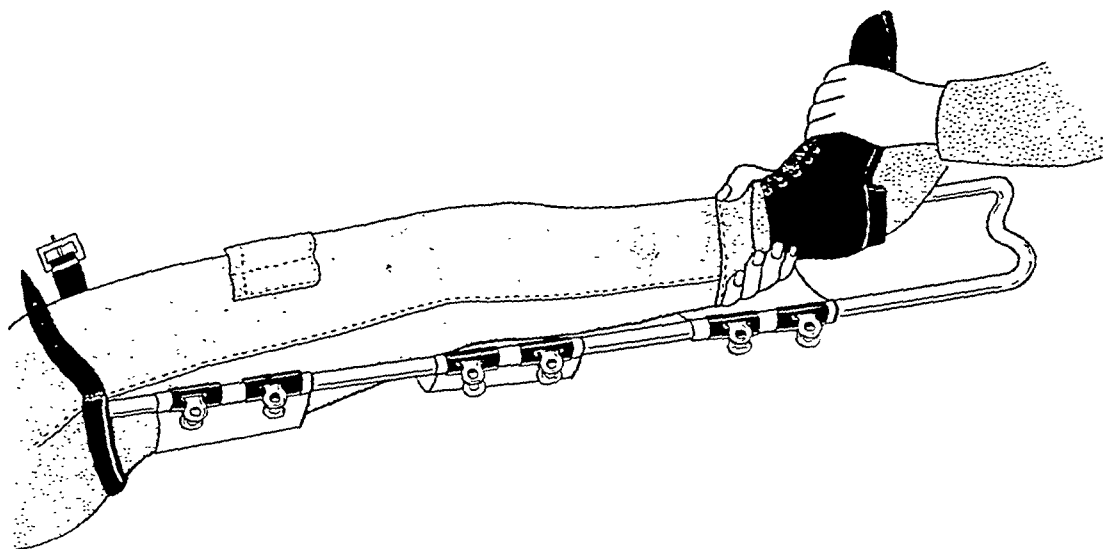


FIG. 1. Showing method of applying the traction and the splint which has been prepared and is being held under the leg while the traction is maintained.

splints are exchanged as the patient is moved from one agency to another. When the patient comes to the admitting office with a splint on, another splint is put on the ambulance to replace it, then as he is moved to a ward the admitting office takes a reserve splint from the ward. There is no loss of material or splints by any one ambulance, hospital or department. Whenever a fracture is transported by an ambulance the fracture box is exchanged for a freshly filled one.

At Bellevue Hospital a demonstration of methods of application is given by the attending staff every six months. The newly appointed house staff, most of whom will serve a term as ambulance surgeon during their service, attend. The equipment is described; methods of exchanging splints and refilling boxes discussed; and a demonstration of the method of application of all types of emergency splints is given. The internes are encouraged to apply splints to each other for practice. The members of the attending staff responsible for the care of fractures observe all injuries on admission to insure proper splinting.

The patient is never moved from the scene of the accident until fixed traction has been applied. No clothing is removed except in compound fractures and then only as described below. If the diagnosis is not made with sufficient certainty while the clothing remains on the patient the case is treated as a fracture and splinted until roentgenograms are taken. Not using a splint is the only error possible; its use on a contused hip, being treated as a fracture until proved otherwise, is commended.

The ambulance surgeon, in the absence of a head injury, administers one-quarter grain of morphine by hypodermic injection. He then grasps the foot of the injured leg and applies gentle traction (Fig. 1). The attempt is made to maintain this traction until such time as traction is no longer necessary in the treatment of the case. The ambulance driver or some other person is pressed into service as assistant to continue the traction. The foot is handed to him in such a manner that the pull is not interrupted. The surgeon then prepares the Keller-Thomas splint. Holding it so that the short side of the splint will be applied

to the inner side of the thigh, the half ring is bent perpendicular to the splint. Several hammock slings are clipped to the splint is being done traction is maintained by the assistant. A simple hitch arrangement as illustrated in Figure 2 is used to replace the

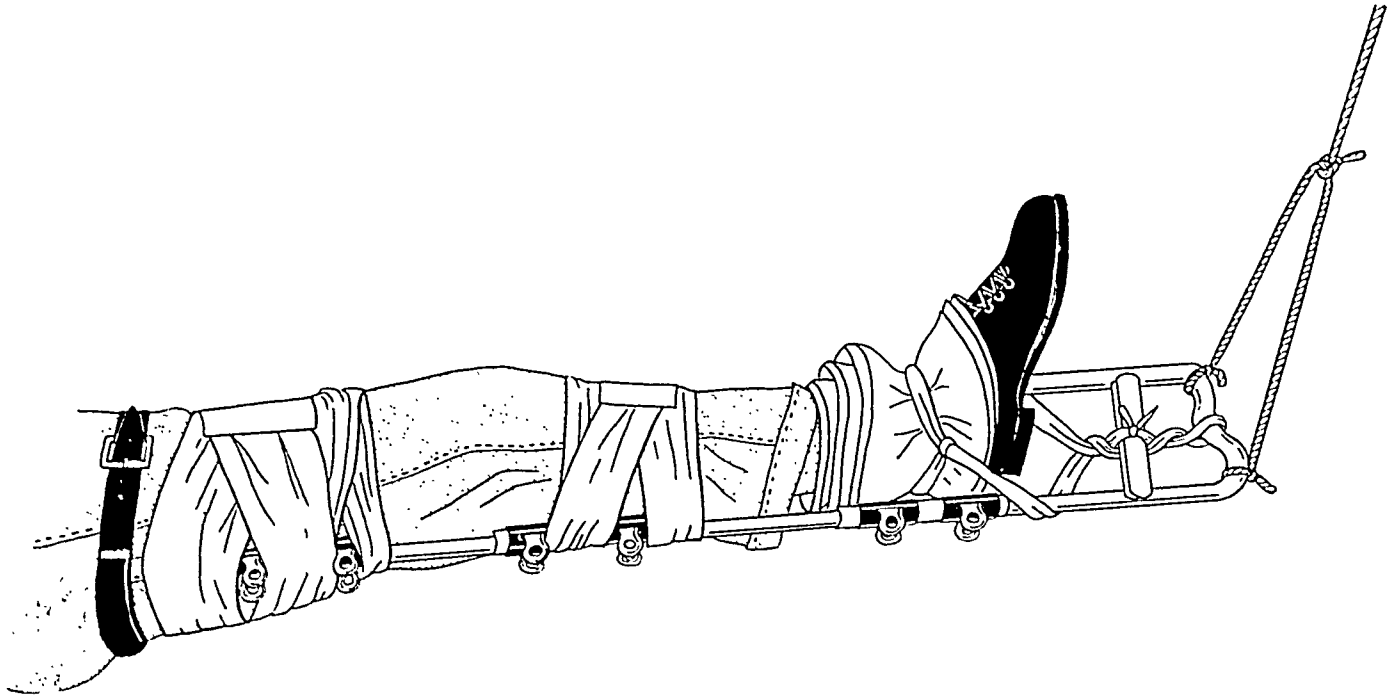


FIG. 2. The splint completely applied. Note the padding about the ankle joint and that the shoe and clothing are undisturbed.

arms in regions which will correspond to the thigh and calf. The splint is then placed under the injured leg with the ring pressed firmly against the ischial tuberosity, the lower end supported against the assistant's body.

Several layers of non-absorbent cotton are wound around the ankle region over the shoe and other clothing to protect the soft parts from pressure. Heavy shoes or trousers are a distinct advantage as they form a firm covering from which traction can be taken. The ring of the splint is completed by fastening a strap over the anterior half of the thigh at the upper end of the splint. The leg is bound to the splint by bandages encircling the leg and splint for a short distance above the knee and a similar distance below the knee. While this

manual traction. Muslin bandages passed over the sides of the splint, which act as spreaders, are tied at the lower end. A small block of wood or several tongue sticks are used to create a Spanish windlass which may be wound to the desired degree of traction. The assistant is thus relieved. Ropes are tied to the end of the splint to afford a means of suspending the leg from the roof of the ambulance. The patient is then carried to the ambulance on an ordinary litter.

After a few practice attempts the whole procedure can be carried out in less than five minutes, and should not take more than fifteen minutes at the first attempt. It may be taught in a few moments to any interested person whether he is aware of the principles involved or not. The main

features are traction from a well padded ankle region and a Thomas splint.

In compound fractures the procedure is precisely the same after the wound has been treated. In the presence of bleeding or obvious compounding the clothing in the region of the fracture is cut away with a scissors and a minimum of motion. A solution of one-half strength tincture of iodine is poured over the wound and a sterile dressing applied. No attempt to reduce the bones is made. If it should be reduced during the application of the traction note of that fact is made and reported to the surgeon in charge of the case. Active and obviously serious bleeding is controlled by a tourniquet. The rules concerning removal of the tourniquet at intervals of twenty minutes are carefully observed.

The patients may be left in traction for hours if they are carefully observed. The only possible source of danger is the ankle bandage. If it has been applied over a shoe with generous padding that danger is reduced to a minimum. Sensation in the foot and the ability to move the toes are sufficient indications of the degree of constriction. The traction is always adjustable.

The experience of all the fracture surgeons treating cases so transported is that most shaft fractures are reduced when they arrive at the hospital even though no express effort is made to reduce them completely. The ease with which complete reduction can be secured and permanently held is far greater than in the period before any plan for transportation was organized. That the patient is comforted and relieved of pain is well worth the effort.

Transportation in fixed traction prevents many of the complications of hip fractures in the aged. While these patients are more insensitive to pain during movement, the depth of traumatic shock seems to be in direct ratio to the amount of motion. Certainly no risk is involved in the use of fixed traction, and while there may be valid reasons for "sandbagging" some of them, the decision had better be made after careful study in the hospital. The peripheral

circulatory paralysis of traumatic shock is probably the cause of most of the complications which contraindicate active and adequate treatment of hip fractures.

While this plan is a decided improvement at Bellevue Hospital it cannot be perfected by the hospital authorities alone. Unfortunately they are not the first to reach injured persons. It is difficult for many people to appreciate that they are not doing a kindness by removing an injured person to shelter or to the hospital. That a man struck by an automobile is better off lying in the gutter until an expert at removing injured people comes is hard to teach to the public. Further educational effort is therefore being directed at those most likely to come in contact with the injured, policemen, chauffeurs, street car employees, etc.

The efforts of fracture committees in large urban centers have been rewarded. There, carefully taught and supervised ambulance attendants carry out an organized scheme. In large industrial plants the control over accidents and first aid permits the use of intelligent splinting. On remote highways, however, the difficulty is great. Efficient ambulance service cannot be maintained and equipment is not available. Unfortunately the most essential part of the equipment, the Thomas splint, is not easily improvised. In those injured in high speed accidents the need is greatest and the distances to be carried the farthest. Palmer<sup>2</sup> suggests the enlistment of local medical societies, state highway patrols, automobile clubs, chambers of commerce, boy scouts, telephone companies, private ambulance concerns, and county officials in an educative campaign. At the present time some organizations are depositing splints at accessible roadside points such as gas stations and police stations. It is suggested that physicians carry splints in their cars.

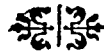
The economic value of splinting a fracture of the shaft of the femur has been expressed in a number of ways. One aphorism states that for every minute

<sup>2</sup> PALMER, E. P. Airway and highway first aid stations. *Surg., Gynec. and Obst.*, 62: 446-448, 1936.

during which the patient is transported while he is unsplinted a week is added to his disability time. Palmer<sup>2</sup> says: "It is estimated that there is an average saving of one hundred dollars in the treatment of each extremity fracture in which the fixed traction method (for transportation) is used." It is known that fractured femurs which occur in highway accidents or civil life take longer to be rehabilitated than those which occur in well regulated industrial plants. Expert aid, in these latter cases, is always close at hand. Workers can be instructed that no injured fellow workman may be moved and that machinery must be stopped until skilled surgical aid arrives.

#### SUMMARY

First aid for fracture of the femur and hip is not temporary provision for the comfort of the patient. It is early treatment of the most effective kind and prevention of further injury. That the application of fixed traction at the site of the accident will prevent further injury and make the treatment eventually selected more satisfactory has been proved. Further education must be directed toward those most likely to come in contact with injured persons. At least they should be taught that no injured person may be moved until they have been properly splinted. The medical profession in general can aid in the spread of this knowledge.



# OFFICE SURGICAL TREATMENT OF INJURIES OF THE KNEE

ROBERT M. TOLL, M.D.

Assistant Surgeon, Coney Island Hospital; Associate Gynecologist, Beth Israel Hospital; Associate Surgeon, Manhattan General Hospital

NEW YORK CITY

THE term knee is used to include the joint and the structures about it. The knee joint is the largest articulation in the body and is elaborate in its structure. Its function is to support the body, maintain the upright position, and aid in locomotion. These duties subject it to frequent strains and stresses, mild or severe. When these injuries are disabling they become of special moment to the worker whose capacity to do is interrupted, and to the insurance carrier which may cover the risk under the Workmen's Compensation Laws. In all these injuries the aim of treatment is to conserve function. The extent of success or failure to do this will be the measure of loss directly to the injured, to industry and to society.

Many injuries in and about the knee joint can be safely and effectively treated in the office. These injuries may be grouped into two classes:

1. Extrinsic, or those about the joint.
2. Intrinsic, or those to the joint.

## INJURIES ABOUT THE JOINT (EXTRINSIC)

*Abrasions and Superficial Lacerations.* Paint with iodine, remove foreign matter, debride, administer tetanus antitoxin, and cover with a sterile dressing.

*Burns.* Cleanse, debride, spray with 5 per cent tannic acid or apply amertan.

*Contusions.* Mainly important because of blood extravasation. To check this apply rest, cold and pressure. After several hours cold application is discontinued and absorption is hastened by the application of moist heat and massage.

## Wounds.

1. *An incised wound* is usually clean and may be sutured after cleansing and application of iodine.

2. *A lacerated wound*, if clean, may be closed; if not clean, it should be left open.

3. *Punctured wounds* should not be closed. They may be infected, though many heal without suppuration. Probing such a wound is dangerous, it may carry infection deeper. It is not necessary to probe to determine if the joint has been penetrated. The only guide to this is the escape of synovial fluid which knowledge does not alter treatment. If the wound has been made by a pointed instrument it is usually sufficient to treat promptly with iodine, insert superficially a rubber tissue drain, cover with a sterile dressing, and immobilize the joint.

4. *A granulating wound* requires only protection. Healing may be hastened by exposure to Alpine light or an ordinary electric bulb. Sloughs should be removed. Balsam of Peru applications may hasten granulation.

*Ulcers* are areas of tissue destruction resistant to treatment. They follow wound infections; they result from burns due to cold, heat, chemicals or electricity. They may be influenced by constitutional disease.

*Treatment.* *Local*—cleanse, support (rest, elevation, elastic bandage); stimulate (light, scarlet red).

*General.* Check constitutional factor and treat, if present.

*Bursitis.* Exclusive of the prepatellar bursa there are some half dozen others scattered about the knee joint at points of pressure and friction. On the inner side of the knee there is (1) a large bursa between the inner condyle of the femur and the inner head of the gastrocnemius and semimembranosus, and (2) a small bursa be-

tween the tendon of the semimembranosus and inner tuberosity of the tibia.

On the outer side of the knee there is (1) a bursa between the popliteus tendon and the external lateral ligament; (2) one between the popliteus tendon and head of the tibia; (3) one between the biceps tendon and external lateral ligament; and (4) one between the external condyle of the femur and the outer head of the gastrocnemius.

These are subject to enlargement from direct trauma or from prolonged standing and exertion. The prepatellar bursa is most commonly affected. Bursitis is characterized by localized swelling, tenderness, and interference with function.

*Treatment, Acute Stage.* Aspiration, strapping, heat.

*Chronic Stage.* Aspiration with injection of an irritating fluid (iodin, phenol); heat (lamp, diathermy, short wave).

#### INJURIES TO THE JOINT (INTRINSIC)

*Sprains* are usually due to sudden twists or undue use of the joint and involve the joint, capsule or ligaments, usually the internal lateral. They are marked by pain on movement, and by swelling due to fluid in the joint.

*Treatment. Immediate*—Cold, followed after several hours by moist heat; rest (posterior splint, or light plaster cast for not more than ten days); adhesive strapping (must leave a gutter posteriorly to avoid circular constriction); early motion is important. *Later treatment* for the swelling, stiffness and weakness—Heat (lamp, diathermy, short wave) to promote circulation; massage to aid absorption; graded active and passive exercises to stretch adhesions. The average case should show complete recovery after three to four weeks under this treatment. Continued subjective complaint beyond this period without definite objective signs (swelling, discoloration, muscle spasm) justifies the suspicion of hysteria or malingering.

*Synovitis* is most common in the knee. It seldom results from direct trauma, usually

coming on after indirect violence such as a sudden twist which produces intrinsic damage. Synovitis is characterized by fluid in the joint, fluid that is usually mixed with blood. If the damage to the joint leaves some loose body or an unhealed tab the articulation may become unsteady and painful and tend to recurrent effusions.

*Treatment.* In the acute stage the same course may be followed as for sprain. If the effusion is marked immediate aspiration of the fluid is advisable, followed by the measures named. Motion should be begun early, about the fifth day. Too long splinting leads to atrophy and joint stiffness.

*Joint cartilages* may be damaged by the same injuries which cause sprains and synovitis. The damage is rarely due to direct violence; nearly always it follows a sudden twist or wrench of the partly bent knee. The internal semilunar cartilage is the one usually affected (about 20 times more frequently than the external). The damage is either a dislocation or fracture. The dislocation may lock the joint in partial flexion, necessitating reduction of the cartilage to permit voluntary extension of the leg. To bring about reduction it is necessary to widen the joint space and so unlock the cartilage. This can be accomplished in one of several ways: (1) Hyperflex the joint and press the cartilage back with the fingers. (2) Flex the joint, pull the leg down and have the patient kick the knee straight. (3) Have the patient sit on a table and swing the leg back and forth, often the cartilage slips back of itself. The associated synovitis is treated as described. Operation is best not considered unless recurrences take place.

*Recurrent or chronic displacement* is best treated by surgical removal. The best results are obtained if operation is done before joint changes take place. Recovery then takes six to twelve weeks. Operation after joint changes occur requires six to twelve months for complete recovery. If operation is not practical or is refused then treatment must consist of some form of support, as an elastic knee cap, or a knee

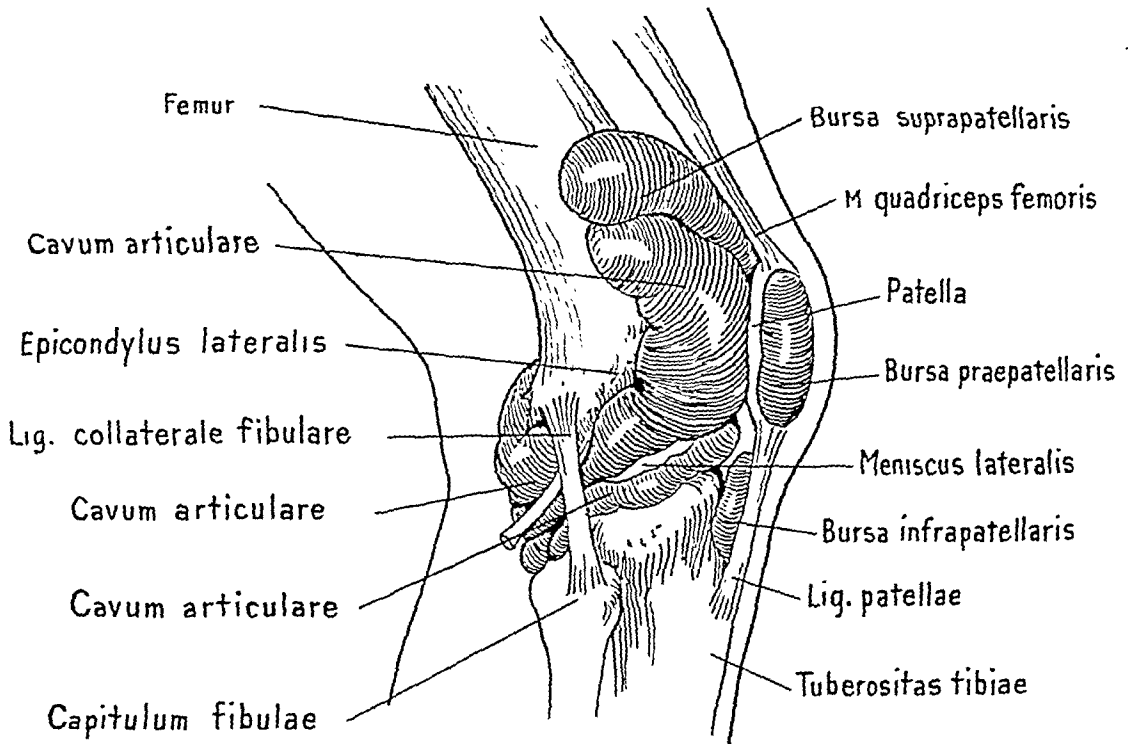


FIG. 1. Intrinsic structures of the knee.

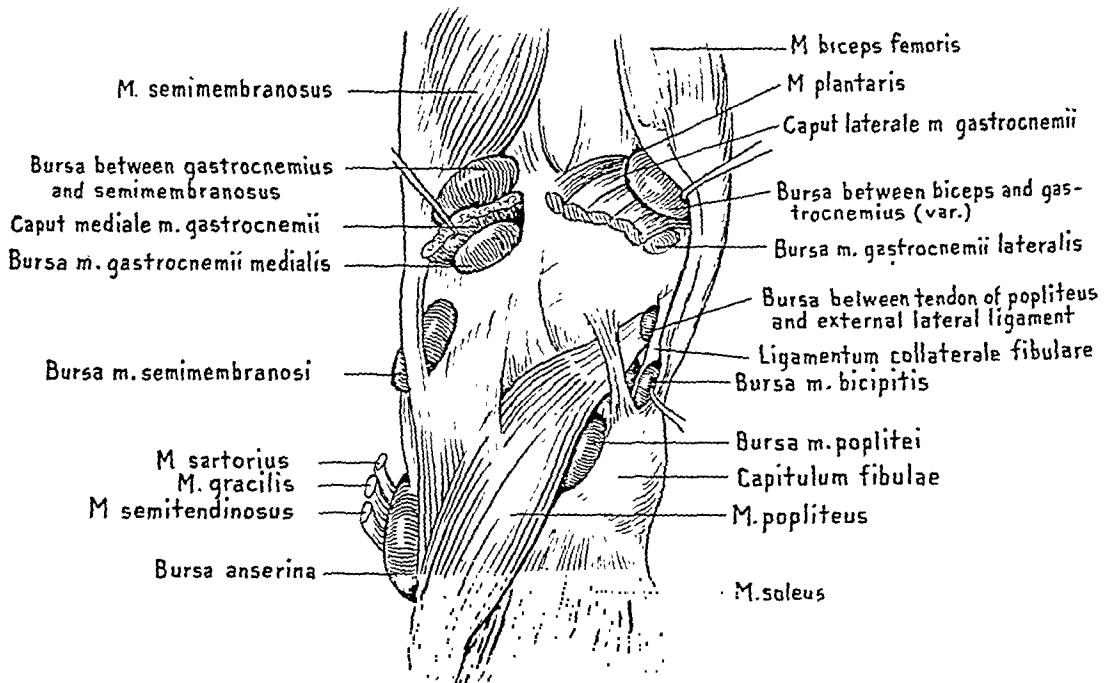


FIG. 2. Extrinsic structures of the knee.

brace, together with baking, massage and graded motion. The physiotherapy will help lessen the atrophy and weakness to the joint which usually accompany fixation of the joint.

*Dislocation of the knee* forward is the most common; next in frequency is backward and the rarest form is the lateral, either internal or external. Reduction is easy in recent cases. Traction alone or with manipulation (extension, flexion) is usually effective. The associated synovitis is treated as described.

*Dislocation of the Patella.* The outward form is the most usual; the inward form is rare. Replacement is usually not difficult. Reduction is made by pressure with the leg in extension. The synovitis is treated as outlined. A posterior splint is applied. Massage is begun at once and motion after several days. Walking may be allowed at the end of a week. Repeated dislocations require surgical intervention.

*Stiff joint* may follow as a direct result of injuries in and about the knee, or it may follow secondarily as a result of injuries to the limb distant to the knee, especially fractures of the femur. In the latter the stiffness results from weakness of the muscles controlling the joint and adhesions in the ligaments and tendons about the joint from lack of use. Stiffness is also produced by fixation of muscle to the bone at the site of the fracture. To restore function attention is directed to (1) increase of local circulation by application of heat, massage and hydrotherapy; (2) breaking up of adhesions by resistance exercises, careful and graded manipulation.

#### DISABILITY

If *stiffness* prevents full extension of the knee the joint is always somewhat unstable because the final locking movement in extension cannot be obtained. Disability will depend on the nature of occupation

and the degree of restriction. With complete extension and flexion to 60 degrees walking should be normal and the injured should be fit for most heavy work not requiring kneeling. Any degree of stiffness disables one from being an acrobat or professional dancer.

*Ankylosis* most commonly results from fractures into the joint. The optimum position for bony ankylosis is with the leg flexed about 3 degrees. For fibrous ankylosis the optimum position is with the knee fully extended. This puts the least strain on the fibrous tissue in the joint. Ankylosis incapacitates the patient for most laboring work but does not unfit him for bench work.

*Instability* of the knee is more disabling than stiffness. It results mainly from weakness of the vastus internus from disuse. In part it is due to laxity of the joint produced by traction during treatment of fracture, resulting in stretching of the ligaments of the joint. Wearing a tight bandage about the knee increases wasting of the muscles. An unstable joint unfits the worker for ladder climbing and working at a height.

The *measure of disability* cannot be gauged by the amount of creaking on movement. Disability must be estimated from the degree of pain, restriction in movement and instability of the joint. These depend on structural changes resulting from the injury.

#### SUMMARY

1. The importance of the knee is stressed as a functional, industrial and social asset. Treatment must be directed to the preservation of these qualities.

2. Injuries to the knee which can be safely and effectively treated in the office are enumerated and their care described.

3. Various disabilities are noted and their permanent effects stated. Their evaluation must be based on objective findings.



# TREATMENT OF HALLUX VALGUS (BUNION)

W. P. ARMSTRONG, JR., M.D., F.A.C.S.

Attending Surgeon, Springfield and St. John's Hospitals

SPRINGFIELD, ILL.

THE term bunion has clouded the average physician's conception of the pathological alterations underlying a common but complicated deformity of the foot. The name connotes an inflamed bursa and a bony exostosis as the chief pathological changes.

The bony exostosis and the inflamed bursa are but complications of what may be more aptly termed the "hallux valgus syndrome." The first metatarsal bone is deflected mesially and is rotated in its longitudinal axis, the phalanges are deflected outward and rotated, and the sesamoids are displaced laterally into the intermetatarsal space. The deformity, once established, is maintained and accentuated by muscular imbalance. The constant friction and the repeated traumata of walking, concentrated on the inner aspect of the metatarsal head, which is thus rendered prominent, result in increased activity of the periosteum with consequent bony overgrowth. The bursa lying between the skin and this exostosis, because of repeated subjection to these same trauma, becomes the seat of an inflammatory reaction.

Since mesial deflection of the first metatarsal is the notable deformity in each instance of hallux valgus syndrome, the cause of this change must be determined and the removal of this cause must be the first step in treatment. This deflection of the first metatarsal may be the result of splay foot, it may be a congenital condition, metatarsus varus primus, or it may be due to the presence of an os intermetatarsale, the latter two being relatively infrequent.

In splay foot there is a spreading of the foot in the region of the metatarsal heads, chiefly between the first and second metatarsals. This spreading is permitted by the

weakened transverse metatarsal ligament which is attached to the plantar aspects of all of the metatarsal heads and is adherent to the capsular ligaments of all of the metatarsophalangeal joints. Splaying of the foot, one important element of which is mesial deflection of the first metatarsal bone, may appear in a congenitally relaxed foot; but even in a normal foot it will arise when the foot is held constantly in the pronated position during locomotion.

Certain strains, chiefly those centering about the anterior portion of the foot, are accentuated when the foot is pronated during locomotion. Strain on the forefoot is normally greatest during the rise for the take-off in walking because the entire body weight during this phase is dissipated to the ground through the metatarsals as they are rising to a vertical position. The metatarsal heads, encased in a tightly fitting, smooth stocking that rides on the frictionless leather insole of the shoe, slide forward and laterally. When the body weight is raised over a normally inverted foot, with the line of the metatarsal heads perpendicular to the line of progression, the spreading forces acting on the intermetatarsal ligaments are at a minimum. When the foot is in the pronated position, these spreading forces on the first metatarsal head are greatly increased and a considerable stretching force is thus applied to the plantar ligament connecting the first and second metatarsal heads (Fig. 1). Lake<sup>1</sup> has emphasized the role of the high heel in increasing this tendency toward splaying through its action in increasing the proportionate body weight applied to the anterior region of the foot (Fig. 2). The high heel undoubtedly accounts in great part for the greater frequency of bunion among women.

Congenital varus of the first metatarsal, generally referred to as metatarsus varus primus, is usually considered as an atavistic reversion to a separated and opposing first digit that can be used for prehension, similarly to the human thumb. In this condition the metatarsal face of the first cuneiform bone is inclined toward the medial side of the foot to an increased angle, much as in the foot of the ape.<sup>2-4</sup>

The os intermetatarsale is an infrequently encountered supernumerary bone situated between the bases of the first and second metatarsals. It acts as a wedge between these bones, causing a mesial deflection of the first metatarsal.

The first step in constructing an accurate interpretation of the deformity is a determination of the element or elements responsible for the metatarsal varus, that is, one or more of the three foregoing. The forces producing phalangeal valgus and metatarsophalangeal rotation may then be considered. Inflammation of the metatarsal bursa and the exostosis on the metatarsal should be viewed as complications of these primary deformities. Proper treatment can follow no other conception.

Valgus of the phalanges is the result of increased pull of the small adductor muscles under tension, of misdirected pull of the displaced extensor and flexor hallucis longus tendons, and of stretching and loss of function of the small abductor hallucis (Fig. 1). There is no muscular attachment to the first metatarsal head. It is these muscles that prevent the toe from following the metatarsal in its mesial deflection in hallux valgus syndrome. As metatarsal deflection increases, the phalangeal base is pulled laterally on the convex metatarsal head by these small muscles and is finally deflected outward (Fig. 3). This outward deflection of the phalanx may be accentuated by short and improperly designed shoes.

The tendon of the flexor hallucis longus passing across the plantar aspect of the metatarsophalangeal joint, in a groove between the sesamoids, and the tendon of

the extensor hallucis longus passing over the top of the joint both have a slight natural tendency to pull the toe outward.

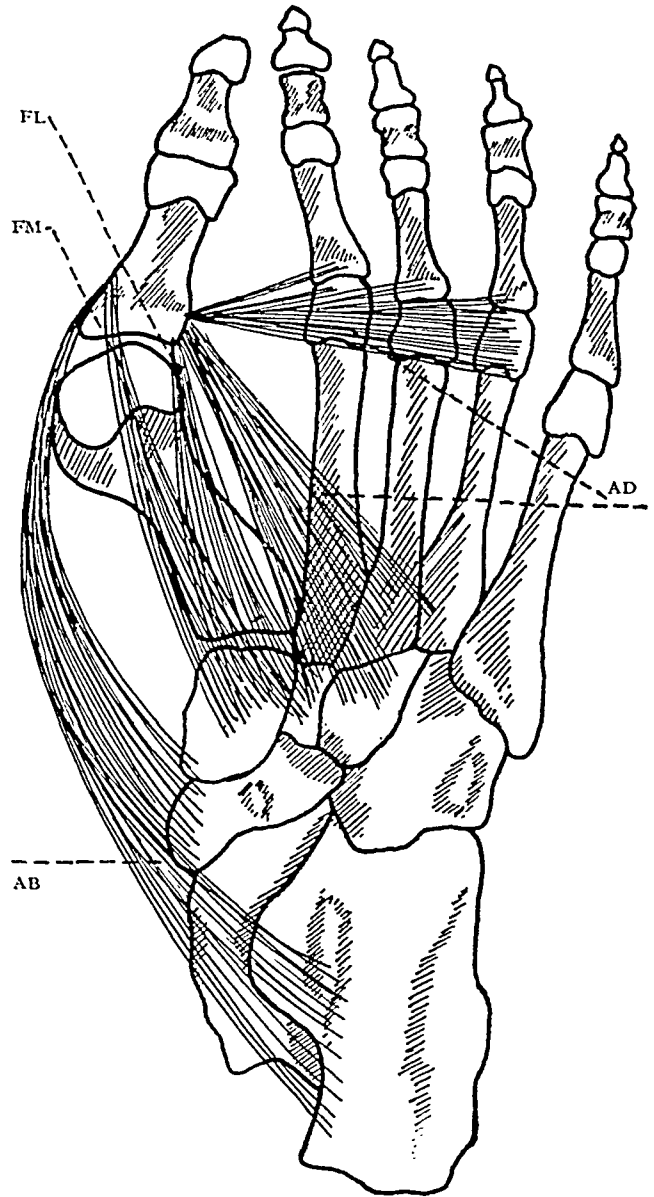


FIG. 1. AB, abductor; AD, adductor; FL, flexor brevis (lat.); FM, flexor brevis (med.). The small muscles on the plantar surface of the foot that are of importance in hallux valgus. Note that no muscle is attached to the first metatarsal head.

Once the valgus deformity has set in, the pull of these tendons is an important factor in increasing it.

Rotation of the first metatarsal and rotation of the phalanges so that the nail faces medially (Fig. 4) are produced by the same forces. After metatarsal varus and phalangeal valgus have become pronounced, the abductor hallucis and the medial head of

the flexor hallucis brevis are on a stretch. The lateral head of the flexor hallucis brevis is not. The medial head, attached to the medial side of the base of the phalanx, pulls the inner side of the phalanx plantarward, thereby causing the nail to face inwardly. Probably of more importance as a factor in rotation is the location of the transverse intermetatarsal ligament on the plantar aspect of the metatarsal heads. This restrains the plantar portions of the metatarsals to a greater extent than the dorsal portions in the spreading of splay foot. The result is a tendency for the first metatarsal to roll inwardly and the fifth metatarsal to roll outwardly. With angulation at the metatarsophalangeal joint the sesamoids are carried laterally with the tendon of the flexor hallucis longus. The movement of the sesamoids to the lateral side of the metatarsal head helps to produce rotation of this bone. As Graham<sup>5</sup> has pointed out, the very important function of the peroneus longus in holding the first metatarsal to the ground, and thus stabilizing it, is lost in the pronated foot, and diminished function of this muscle leads to inward angulation and rotation of the metatarsal.

The following is a résumé of the changes described and may be used in establishing an accurate diagnosis upon which treatment is based.

1. Metatarsal Varus
  - a. Splay foot
  - b. Metatarsus varus primus
  - c. Os intermetatarsium
2. Phalangeal Valgus
  - a. Abnormal pull of adductor muscles
  - b. Displacement of flexor hallucis longus and extensor hallucis longus
  - c. Stretched and atrophic abductor hallucis
3. Rotation of Phalanges
  - a. Abnormal pull of medial head of flexor hallucis brevis
  - b. Plantar resistance of transverse intermetatarsal ligament

4. Rotation of Metatarsal
  - a. Lateral displacement of sesamoids
  - b. Loss of peroneus longus function
  - c. Plantar resistance of transverse intermetatarsal ligament
5. Exostosis of Metatarsal Head
6. Inflamed Bursa

Treatment is directed toward correction of metatarsal varus, correction of phalangeal valgus and rotation and eradication of the complicating inflamed bursa and bony exostosis. The therapeutic measures employed in correcting metatarsal varus will depend upon the underlying causative factor as outlined. Measures attacking the actual hallux valgus syndrome will vary with the degree to which the syndrome has progressed. Each case must be treated individually.

#### TREATMENT OF SPLAY FOOT

Unfortunately the splay foot observed in connection with hallux valgus deformity is usually of long standing. The indifference displayed by the profession toward cases of hallux valgus that have not progressed to the stage of incapacitating distress and unsightly deformity has forced patients to the door of the chiropodist for palliative padding and splinting. In the far advanced cases painful callouses are present beneath the anterior metatarsal region and indicate a completely flattened forefoot; muscle spasm, periosteal thickening and periarticular adhesions have produced a rigid or semirigid foot as Nature's attempt to immobilize an irritated section of the body.

In these advanced cases preliminary manipulative treatment without anesthesia at frequent intervals, preferably daily, must be carried out until active and passive motion in the joints has improved to such an extent that the foot can be forced into an approximately normal position. Each joint in the foot is moved to the limit of comfort in each direction. Manipulation once weekly with the patient anesthetized may supplement the daily manipulation. Great care must be exercised when manipu-

lating the foot of the anesthetized patient as harm may result from injudicious stretching.

foot. This should be supplemented by a combined longitudinal and anterior support that extends well up under the necks

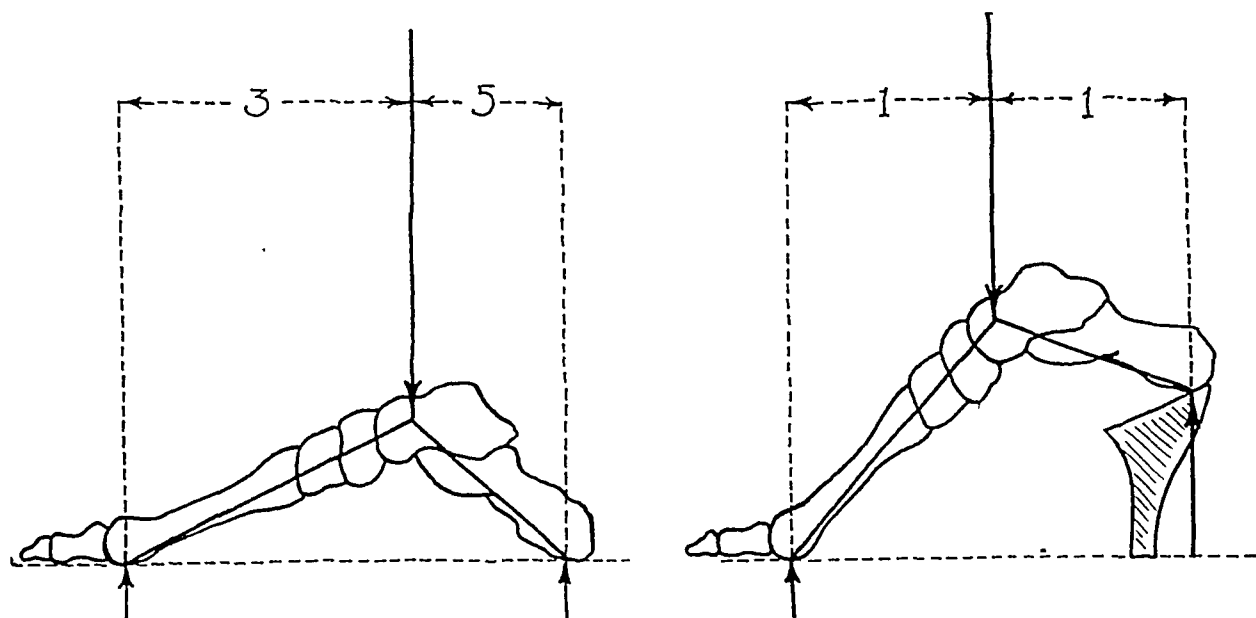


FIG. 2. The effect of the high heel in throwing an abnormally large proportion of the body weight on to the anterior portion of the foot.

When the foot can be maneuvered into a fair position without discomfort, a readjustment of weight distribution on the feet is begun. In effecting weight readjustment the outline for the treatment of the weak foot as recommended by Graham<sup>5</sup> is of great benefit because of its systematic attack and its practicality. This routine emphasizes re-education of pelvic, leg and foot posture. The proper degree of pelvic inclination is impressed upon the patient by means of a "wall maneuver" in which the small of the back approximates a wall when the head, shoulders, buttocks and heels are touching the wall. External astragalar rotation on the calcaneus is attained by twisting the leg outwardly on the foot. The action of the peroneus longus in stabilizing the first metatarsal pillar of the foot is developed in the "chair maneuver." In this exercise the patient, after fully adducting the foot while sitting on a chair, alternately raises the first metatarsal head and pushes it toward the floor.

A snugly fitting, circular, elastic band 2 to 3 inches in width applied just behind the first metatarsal head is of great benefit in compressing the anterior portion of the

of the second, third and fourth metatarsal bones. Firm harness felt makes the best material for the support. The first thickness used should be about  $\frac{3}{8}$  of an inch. This is then gradually elevated. The medial side of the fore part of the shoe should be straight and the heel should not be more than one inch in height.

#### TREATMENT OF METATARSUS VARUS PRIMUS

This is corrected by a wedge excision of the first metatarsal base and the anterior extremity of the first cuneiform to produce ankylosis of the first cuneiformometatarsal joint in the corrected position of adduction and plantarflexion.

A 2 inch incision is made on the dorsal aspect of the foot on a line between the first and second cuneiforms and centering at the first cuneiformometatarsal joint. The extensor longus is retracted and the location of the dorsalis pedis artery is noted so that it may be preserved. The periosteum is lifted from the metatarsal base and from the cuneiform close to the joint. Small wedges with 3 to 5 mm. bases facing laterally are removed (Fig. 5). Whatever por-

tion of the joint surface then remains is excised. It is necessary to carry the base of the wedge plantarward so that the joint

longer. Passive motion at the metatarsophalangeal joint is instituted at the end of one week.



FIG. 3. Reproduction of a roentgenogram illustrating metatarsal varus, lateral displacement of the sesamoids into the first interosseous space and lateral displacement of the first phalanx on the head of the metatarsal.

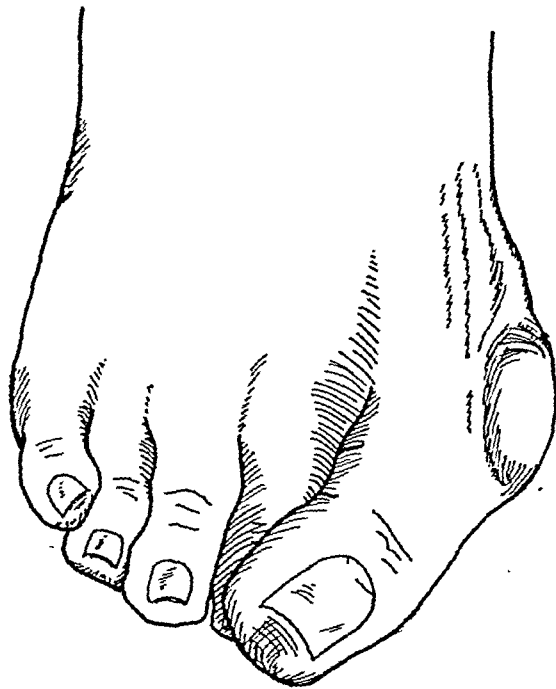


FIG. 4. Sketch of a bunion showing the inward rotation of the phalanges with the nail facing medially.

#### TREATMENT OF OS INTERMETATARSEUM

This bone may be removed through an incision similar to that used in correcting metatarsus varus primus. The bone, of variable size, is situated between the first and second metatarsal bases. The proximity of the dorsalis pedis and its deep plantar ramus passing through the interspace to the plantar arch must be kept in mind since ligation of these vessels adds to the total amount of suture material left in the wound. The bone is best grasped and held with a sharp clamp, such as the ordinary towel clamp. After the bone has been removed, the operator must make certain that the metatarsal can be adducted and plantarflexed into the natural position. When a normal position cannot be accomplished after removal of the bone, a portion of the lateral tuberosity of the first metatarsal base may be pared down with a chisel. Motion should be started within a day or two in these cases.

may be fused in plantarflexion. Occasionally it is advisable to chisel down a prominent lateral tuberosity of the metatarsal base. When enough bone has been removed to allow approximation of the first metatarsal to the second, the joint capsule and the dorsal tarsometatarsal ligaments are sutured and the skin is closed. The metatarsal is held in the corrected adducted and plantarflexed position by adhesive wrapped tightly over heavy felt pads that are cut to fit the plantar surface of the foot. Weight bearing is allowed in four weeks, but the patient must wear a molded steel support beneath the metatarsal six to eight weeks

## TREATMENT OF HALLUX VALGUS

Correction of the hallux valgus deformity, that is, phalangeal valgus with metatarsal and phalangeal rotation, if of comparatively mild degree, may be delayed for some time after correction of metatarsal varus, whether this was due to splay foot, metatarsus varus primus, or os intermetatarsaleum. In the early cases the toe deformity can be improved by anterior metatarsal elevation, a toe post and a splint applied over the medial aspect of the big toe at night. The anterior elevation of the combined anterior and longitudinal support should start at the inner side of the foot just in back of the first metatarsal head. It is extended in a curve around the metatarsal head to make a sweep forward behind the heads of the second, third and fourth metatarsal heads and then back again medial to the head of the fifth metatarsal. The ideal supporting material is harness felt because of its slight resiliency. If a leather envelope is made to fit the insole of the shoe the felt elevation can be increased very gradually and with a minimum of discomfort. When a painful callus is present beneath the second or third metatarsal neck, sponge rubber may be substituted for harness felt. As tenderness in the callus diminishes this may be exchanged for felt. The circular elastic band is an important adjunct to the metatarsal elevation.

The metal toe post molded to fit the individual foot and fastened to a shoe insole is the ideal apparatus for forcing the big toe into a varus position. However, the technical difficulty encountered in procuring an exact fit is great and because of this the stationary toe post is not recommended for general use. A piece of heavy rubber tubing placed end up between the first and second toes works admirably. The tubing is at first compressed between the toes but a separation is slowly accomplished by stuffing the tube with cotton in gradually increasing amounts.

The big toe may be splinted in the varus position at night by tying a padded tongue

depressor to the medial side of the foot and fastening it around the big toe and around the instep, the strap over the instep

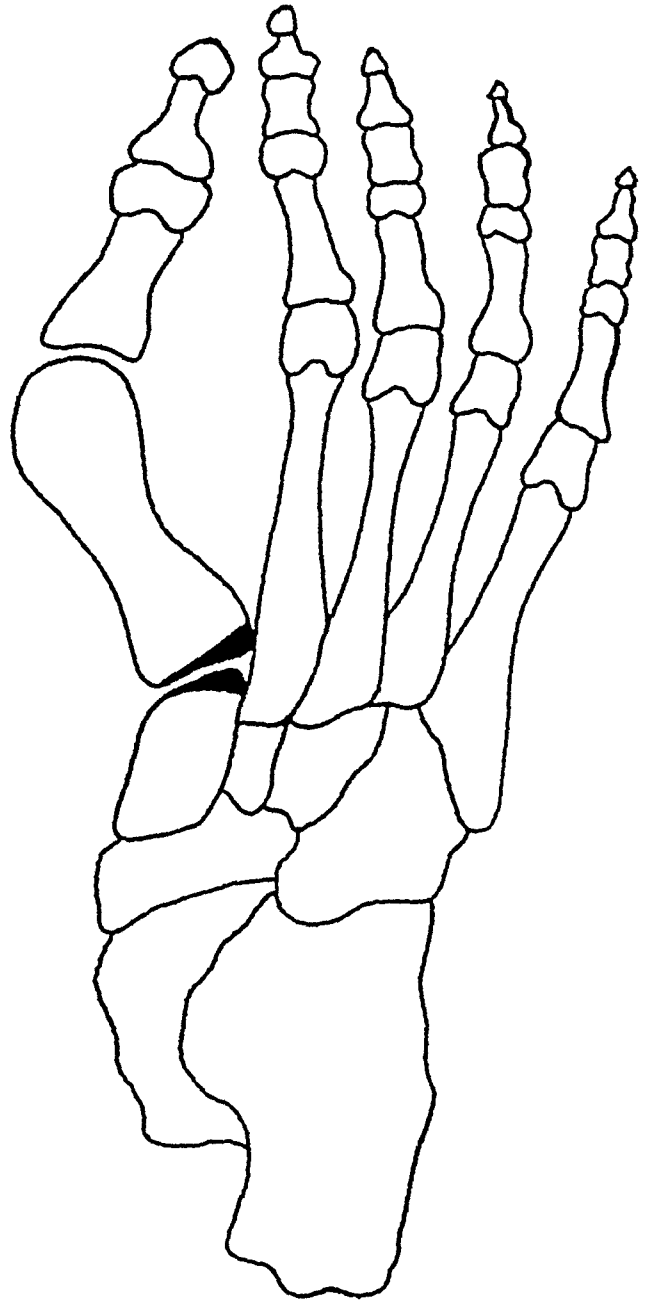


FIG. 5. The blackened areas on the first metatarsal and the inner cuneiform represent the wedges excised.

extending up over the ankle. Most of the manufactured bunion splints on the market are suitable.

The marked hallux valgus deformity of long standing cannot be corrected by the measures that have been described and operative correction must be used. If the deformity is due to metatarsus varus primus or os intermetatarsaleum, the operations on the tarsus and the toes should be

done at the same time. While there is no routine operation for correction of the toe deformity, the procedure advocated by McBride<sup>6</sup> may be used as a basic operation to be varied to fit the pathological changes of the particular case.

A 2½ inch incision is made on the dorsum of the foot beginning in the web between the first and second toes and extending backward to expose the lateral aspect of the metatarsophalangeal joint. Keeping close to the bone, the attachment of the adductor hallucis to the base of the proximal phalanx is exposed. This attachment is severed and is held taut with a chromic suture. The lateral sesamoid is removed from the substance of the lateral head of the flexor hallucis brevis. The adductor tendon held by chromic suture is now attached to the periosteal covering of the lateral aspect of the first metatarsal head.

#### TREATMENT OF COMPLICATIONS (BUNION)

The patient suffering from hallux valgus syndrome ordinarily consults the surgeon for treatment when the metatarsal bursa is acutely inflamed. The pain caused by this inflamed bursa forces the patient to seek aid for a condition that has been no more than annoying for many years. Obviously, the first treatment must be directed toward relieving the acute inflammatory process. This will clear rapidly if the patient stays off his feet and keeps the painful member elevated. Hot compresses may hasten repair. No treatment in the form of manipulations, orthopedic apparatus or operation should be instituted until the acute inflammatory reaction in the bursa has subsided.

Operation is the only avenue for restoring the medial surface of the metatarsophalangeal joint to comfort after a bony exostosis has appeared and inflammatory changes have occurred in the bursa. Removal of the bursa and the exostosis should follow the suggested plastic procedure for hallux valgus deformity. By retracting the medial flap of the incision, the bursa and the bony exostosis can be reached. The bursa is removed and the indurated tissue surrounding it and adhering to the joint

capsule and the tendons of the short flexor and the adductor muscles is excised. The bony prominence on the medial surface of the first metatarsal is chiselled down until the remodelled metatarsal head resembles what might be considered a normal structure. The toe is now placed in a line with the metatarsal and the capsule with the adherent tendon of the abductor hallucis is shortened. The medial head of the flexor hallucis brevis is tenotomized. The skin is closed with a non-absorbable suture and the fore part of the foot is held in place by firm adhesive strapping or by plaster casts, particular care being taken to compress the metatarsal heads and to elevate the second, third and fourth metatarsal necks. Passive motion is started on the second day after operation.

#### SUMMARY

Bunion, consisting of an exostosis of the first metatarsal head and an inflamed bursa, is presented as a complication of the pathological complex, hallux valgus.

Hallux valgus is, in turn, demonstrated to result from inward deflection, or varus, of the first metatarsal. This latter condition, metatarsal varus, may arise in any one of several different ways. It may be the result of splay foot, it may be a congenital condition (metatarsus varus primus), or it may be due to the presence of an os intermetarseum. The mechanism of production is described in each instance.

Treatment is presented in detail under three headings: eradication of the bunion per se; correction of hallux valgus; and correction of metatarsal varus, either operative or non-operative.

#### REFERENCES

1. LAKE, N. C. *The Foot*, Baltimore, William Wood and Company, 1935.
2. TRUSLOW, W. Metatarsus varus primus. *Jour. Bone and Joint Surg.*, 7: 98, 1925.
3. HISS, J. M. Hallux valgus. *Am. Jour. Surg.*, 11: 51, 1931.
4. LAPIDUS, P. W. Operative correction of metatarsus varus primus. *Surg. Gynec. and Obst.*, 58: 183, 1934.
5. GRAHAM, JAMES. Weak feet; pathogenesis and treatment. *Am. Jour. Surg.*, 35: 486-508 (March) 1937.
6. MCBRIDE, E. D. Conservative operation for bunions. *J. A. M. A.*, 105: 1164, 1935.

# TREATMENT OF CONGENITAL TALIPES EQUINOVARUS (CLUBFOOT)

JAMES GRAHAM, M.D.

Attending Surgeon, St. John's Hospital

SPRINGFIELD, ILL.

PRACTICALLY all clubfeet can be completely corrected if proper treatment is begun immediately after birth. Good results, without recurrences, are based upon a gradual reduction of the deformity through a systematic series of manipulations and a period of complete or partial immobilization extending approximately to the weight bearing age, eight months.

Correct manipulation is impossible without an adequate conception of the deformity, which is a contracture of the foot at the extremes of motion in several directions. The several elements of the deformity are readily comprehended upon analysis of normal foot motion, an analysis which is conveniently made on the skeleton of the adult.

The astragalus, fitting in a three sided mortise, may rotate in a vertical plane so that its anterior end may be raised or lowered (Fig. 1). When the anterior end is lowered to the extreme, plantarflexion, the bone may move slightly from side to side, because the posterior half of the articulating surface is narrower than the anterior half, and the posterior half consequently fits the tibiofibular mortise less snugly.

The subastragalar joint between the calcaneus and the astragalus is composed of two parts, anteromedial and posterior (Fig. 2). Philip Wiles<sup>1</sup> resolves movement in this joint into four components: (1) in movement about a vertical axis the anterior end of the calcaneus moves inward or outward below the head of the astragalus (Figs. 4 and 5); (2) in movement about an anteroposterior axis the calcaneus tilts to one side or the other; (3) in movement about a lateral horizontal axis there is vertical raising or lowering of the head of

the calcaneus; (4) in anteroposterior movement there is advancement or retardment of the calcaneus (Fig. 3).

The astragaloscaphoid joint is of the ball and socket type and is enclosed by a very loose capsule. Motion through the joint may be in a horizontal plane, side to side, a vertical plane, up and down, or it may be rotary (twisting).

Only very slight motion is possible in the midtarsus, made up of the cuneiforms, the scaphoid, the cuboid, and the metatarsal bases, because of the complicated interlocking of these bones (Fig. 7). The first metatarsal is an exception. The midtarsus articulates with the calcaneus through the calcaneocuboid joint. In this joint in the infant there is a fair degree of both horizontal and vertical motion, but this is lost in later years.

## EQUINUS

There are two elements to the equinus deformity, both in the same direction (Fig. 6). The back foot, consisting of the astragalus and the calcaneus, is plantarflexed and this position is maintained by the contracted Achilles tendon and by the narrowing of the tibiofibular mortise which is the result of compression of this mortise over the narrower posterior half of the astragalar articulating surface. The wider anterior half of the astragalus, as McGregor<sup>2</sup> puts it, "forfeits its right of domicile" in the three sided tibiofibular box. Plantarflexion of the astragalus and the calcaneus is commonly referred to as "back foot equinus" or "ankle equinus." The back end of the calcaneus is drawn upward, and the whole bone is pulled back, that is, retarded, for about half the length of the astragalus.



The forefoot, in addition to following the back foot into plantarflexion, is further flexed through the midtarsal joints, the foot remain on the ground, the motion being purely horizontal. The scaphoid is moved inward on the head of the astragalus

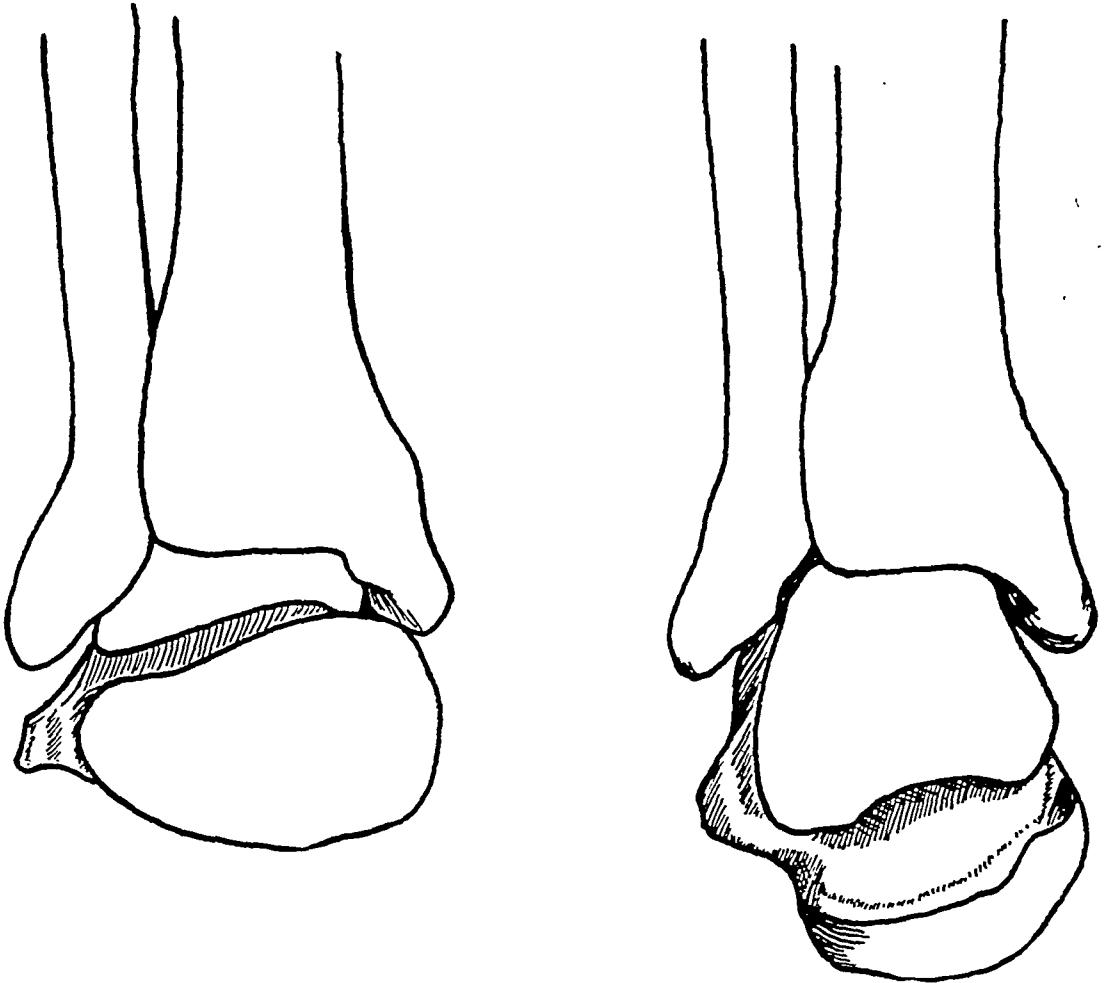


FIG. 1. Illustrating vertical rotation of the astragalus with raising or lowering of the anterior end of the bone. Note that the anterior half of the astragalar articulating surface is wider than the posterior half and that the bone consequently fits into the tibiofibular mortise more snugly when the anterior end is raised, that is, when the foot is in the horizontal position or is dorsally flexed.

astragaloscaphoid and calcaneocuboid, into what Brockman<sup>3</sup> has termed "talipes plantaris."

The equinus deformity, then, consists of plantarflexion of the foot in relation to the leg plus additional plantarflexion of the forefoot in relation to the back foot.

#### ADDUCTION-ABDUCTION

The forefoot is bent inward on a horizontal plane at the astragaloscaphoid and calcaneocuboid articulations (Fig. 8). In adduction both the inner and outer sides of

and the cuboid is moved medially on the anterior articulating surface of the calcaneus. The calcaneus is abducted, that is, the anterior end of the calcaneus moves lateralward beneath the head of the astragalus. The astragalus tends toward adduction but does not completely follow the forefoot. The combined adduction of the forefoot and abduction of the calcaneus thus causes the foot to break at the calcaneocuboid joint so that the first toe and the back of the heel bend around inwardly to meet each other, as it were.

## INVERSION

In inversion the inner side of the foot is elevated and the outer side is depressed

there is inversion of both the calcaneus and the forefoot. The scaphoid is drawn inward and upward, in some instances far

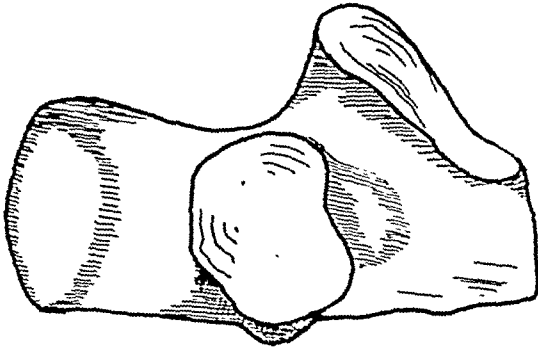


FIG. 2.

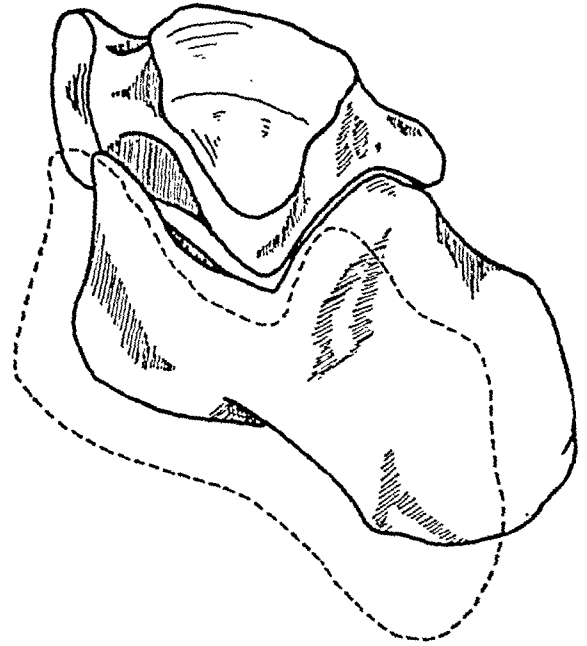


FIG. 3.

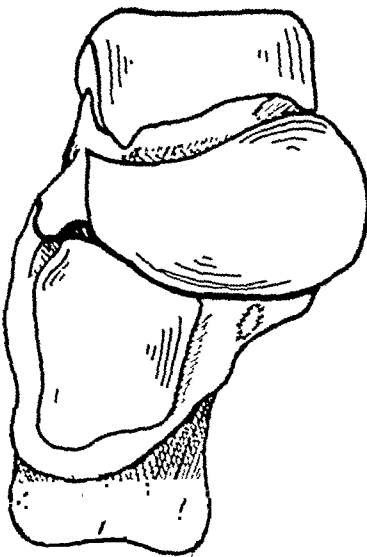


FIG. 4.

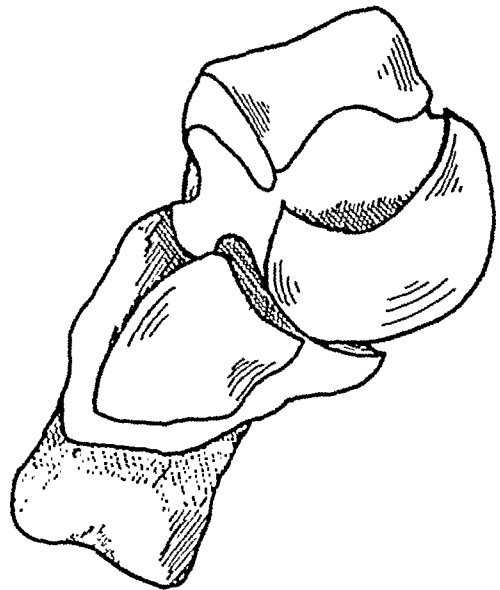


FIG. 5.

FIG. 2. The calcaneus, showing the anteromedial and the posterior articular surfaces into which the astragalus fits.

FIG. 3. Lateral view of the calcaneus and astragalus. The broken line represents the advanced position of the calcaneus.

FIGS. 4 and 5. The astragalus and calcaneus as viewed from the front after removal from the forefoot. Figure 4 represents approximately the normal relationship between the two bones. Figure 5 depicts tilting of the calcaneus (eversion), outward movement of the anterior end below the astragalar head (abduction) and vertical raising of the anterior end (dorsiflexion).

(Fig. 9). This movement takes place through the subastragalar and the astragaloscaphoid joints. In equinovarus

enough to come into contact with the internal malleolus. The fifth metatarsal may be beneath or even medial to the first meta-

tarsal. The calcaneus twists on its longitudinal axis so that the inner side of the bone is elevated and the medial surface

able index to the degree of inversion of the back foot. Back foot inversion takes place through the subastragalar joint.

#### TREATMENT

The treatment of clubfeet must be carried out systematically, although a definite plan can be laid down only for the typical cases that are seen originally during the first few months of life. In the treatment of those cases of clubfoot that have been neglected, or in which inadequate measures have been applied, the routine must be varied to fit the individual condition. Ordinarily, in the early cases, full correction can be accomplished by non-operative measures, and during recent years there has been a decided, and indeed beneficial, tendency to employ operative procedures less frequently. Good results, however, from either non-operative or operative measures are dependent upon a thorough understanding of the deformity and upon a regular and systematic plan of attack directed against it. In some instances subcutaneous tenotomies are indicated in conjunction with posterior capsulotomy. Treatment should be started in the first week of life and a careful watch over the patient must be maintained for three years. The initial correction of the deformity cannot with safety be looked upon as a cure.

Beginning immediately after birth the foot is gradually brought into a position of correction and then overcorrection, this through a series of weekly manipulations and applications of plaster-of-Paris casts. The weekly manipulations entail a serial correction of each of the components of the distortion. While corrections of the individual components merge into a unified correction of the whole, the attack on each component is begun in a definite and logical sequence.

Each week, in the manner to be described, the foot is manipulated and is stretched, without an anesthetic, enough to gain improvement in the position of the cast. Manual stretching is carried out against the direction of each component,

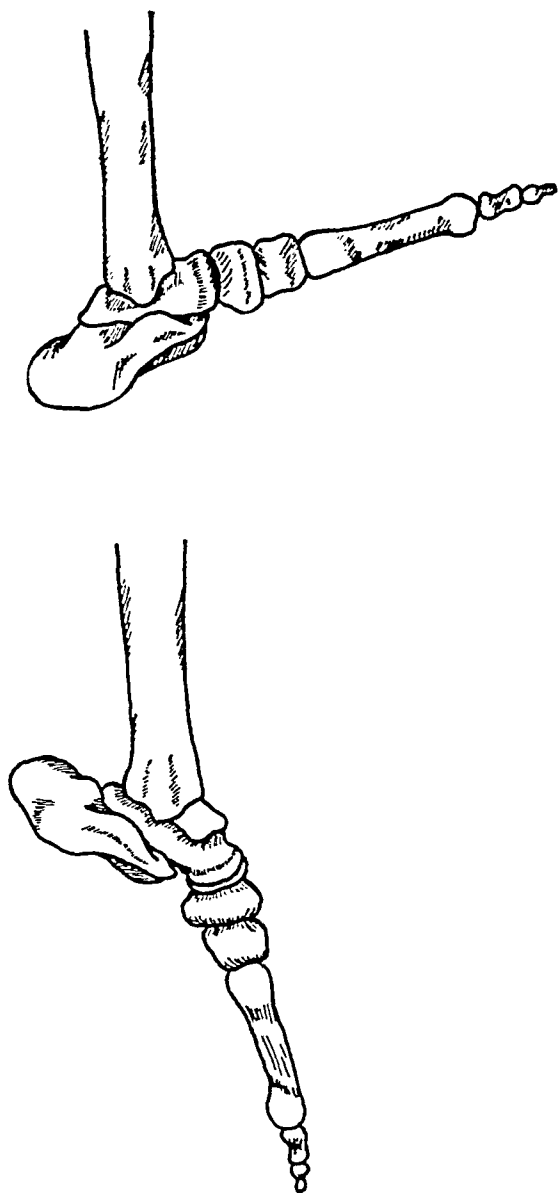


FIG. 6. Lateral views showing the foot in dorsiflexion and in equinus. Note the back foot equinus at the ankle, with the accompanying retardment of the calcaneus, and also the additional equinus of the forefoot on the back foot at the astragaloscaphoid joint. The bones are represented as completely developed, although the low arch of the infantile foot is retained.

moves up to the under surface of the astragalus. The degree of overlapping of the astragalar and calcaneal shadows on the anteroposterior roentgenogram is a valu-

the emphasis being placed on the various components in the order in which they have been attacked. Gentleness in the manipula-

the corrected heel position as well as the plaster cast. Apparently, many surgeons assume that inversion of the back foot is

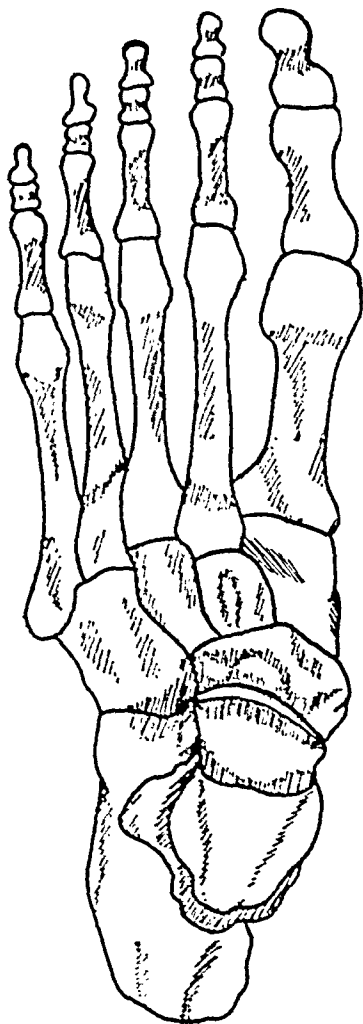


FIG. 7. The normal foot as seen from above. The bones are represented as completely developed.

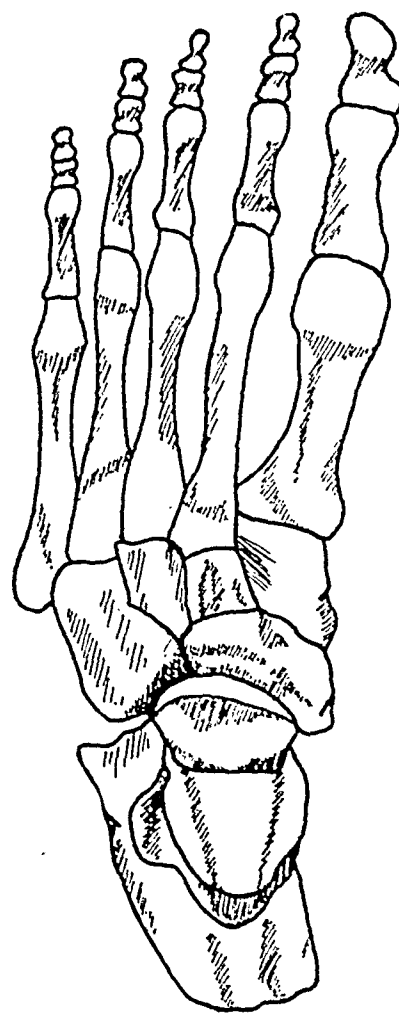


FIG. 8. Illustrating adduction of the forefoot and abduction of the calcaneus through the mid-tarsal joints. Note the medial displacement of the scaphoid and cuboid.

tions is imperative, since harm may result from rough handling. However, a definite gain must be made each week because the structures of the foot become more resistant with time. As long as the infant responds to stimulation of the skin of the foot and as long as the circulation appears to be adequate, correction is not being forced too rapidly.

Until overcorrection has progressed to a fair degree of outward rotation and dorsiflexion, that is, calcaneovalgus, the plaster-of-Paris cast is the best form of retention brace. None of the frequently used methods employing lateral splints, metal plates with elastic bands, or adhesive plaster, holds

automatically corrected as the forefoot is pulled into eversion, but such is not the case, and adequate correction of back foot, or calcaneal, inversion, with maintenance of correction thereafter, demands as much effort as any of the other components.

The plaster cast in these young infants may be extremely light, several thicknesses of 2 inch plaster bandage being sufficient. It should be applied from within, down and out so that correction is held as the bandage is applied. The plaster is applied over a single layer of roller sheet wadding with an extra thickness over such pressure points as the malleoli and the heel. Small slips of

wadding are placed between the toes. The bandage extends from the tips of the toes to the tibial tubercle. As the plaster dries,



FIG. 9. Illustrating inversion. The rotation of the tibia and fibula is only apparent. The tibia is often inwardly rotated on the femur but this is important only in neglected cases.

manual molding of the cast is employed to insure a snug fit. That both the individual applying the plaster and the individual holding the foot in the corrected position during the application should have a thorough understanding of the deformity is an item frequently overlooked. It is certainly inconsistent to exert great care in manipulating and stretching a clubfoot and then to apply a plaster cast while the extremity is carelessly held by a nurse whose knowledge of the mechanism of clubfoot distortion is at best minimal. When the cast is removed at the end of a week, the leg should be cleansed with alcohol, dried and powdered.

Correction of the several components is begun in the following sequence: forefoot adduction, calcaneal abduction, forefoot inversion, calcaneal inversion, forefoot equinus, ankle equinus. The equinus element is left until the last because the taut Achilles tendon holds the heel in the back end of the tibiofibular mortise and thus

affords a fixed point in the foot from which one may work in lining up the forefoot with the back foot. If an attempt is made to overcome the forefoot equinus before adduction has been corrected, the scaphoid, displaced medially on the head of the astragalus, will ride up on the inner side of this bone. The deformity will then recur some time later when weight bearing begins for the simple reason that body weight on the astragalus will be transmitted to the lateral side of the scaphoid when this latter bone is displaced medially, and thus it will be pushed inward, bringing the foot into adduction. In addition, equinus correction produces an improper pull on the calcaneus when this bone is still in the inverted position.

In the manipulation against *forefoot adduction*, the thenar eminence of the operator's hand is placed on the outer side of the infant's foot in such a manner as to cover the external malleolus and the calcaneocuboid joint. The fingers bend around the back of the heel. For manipulation of the infant's left foot, the operator's left hand holds the heel; and contrariwise for the right foot. The butt of the opposite hand is placed against the inner side of the first metatarsal. The two hands are then pushed in opposite directions until the structures on the inner side of the foot become tense. The stretching forces of the hands are slowly relaxed and resumed alternately for a period of several minutes. With each successive application of plaster, the inner border of the foot becomes less concave, then straight, and finally convex. It is to be noted that both *forefoot adduction* and *calcaneal abduction* are overcome by this one maneuver. When the inner border of the foot is convex, the adduction has been overcorrected.

Beginning with the initial cast application an attempt is made to derotate the *inversion components*, both forefoot and back foot. Manipulations to this end, however, should not be as forceful as those directed against adduction-abduction until the inner border of the foot is straight, for

until such a time, the scaphoid has not been returned to its proper central position on the astragalus head. This is usually a matter of several weeks. Forefoot inversion and eversion occur in the astragaloscaphoid joint, and forcing a rotary motion through this joint, by forcibly everting the foot, before the scaphoid is centralized, stretches the surrounding joint structures in an improper manner. The calcaneocuboid joint is likewise subjected to improper stress if eversion is forced before the cuboid has been pushed back, by abductory manipulation, to its proper position directly in front of the calcaneus.

It has been mentioned previously that manipulation against inversion is begun with the initial treatment, but that it is not done with full force until adduction, as judged by the contour of the inner border of the foot, has been corrected. In this maneuver the calcaneus and forefoot are considered as a unit, the underfoot, and this underfoot unit is rotated outward beneath the astragalus. The forefoot rotates through the astragaloscaphoid joint and the calcaneus through the subastragalar joint. Because of this movement of the underfoot through two joints, both sections of the underfoot, calcaneus and forefoot, must be grasped and moved simultaneously. If this is not done, improper stress is thrown on the calcaneocuboid joint.

It is of great importance that the internal and external malleolus are not injured during eversion of the underfoot. Careful and steady manipulation, without jerking, will prevent undue strain on the lower end of the tibia, while the external malleolus can be protected by grasping the foot properly. The ball of one thumb is placed on the external malleolus of the extremity to be manipulated and the ball of the other thumb is placed on the nail of the first thumb. The hands encircle the ankle, one in front and one in back, so that the fingers of one hand may grasp the first metatarsal and the fingers of the other hand may grasp the heel. The underfoot is then rotated outward. When the heel is straight below

the tibia and when the plane of the metatarsal heads is perpendicular to the leg, inversion has been corrected. Slight overcorrection of the inversion is then made, but the extreme overcorrection of inversion that has so often been recommended should be avoided.

When the varus, consisting of adduction-abduction and inversion, has been slightly overcorrected, that is, when the inner border of the foot is convex, when the heel is straight and when the sole faces a shade outward, manipulations for the correction of equinus are begun.

It cannot be too strongly emphasized that there are two parts to *equinus*, plantarflexion of the foot on the leg and additional plantarflexion of the forefoot at the midtarsal region. Attention is directed first toward equinus of the forefoot. In this manipulative maneuver the hand of the operator that is opposite to the side of the infant to be stretched grasps the forefoot well back on the tarsus with the fingers on the sole of the foot. The heel and ankle are held from behind with the other hand. The forefoot is then gradually pulled up until it is in line with the back foot. Correction of back foot equinus is not begun until this has been accomplished. Overcorrection is to be guarded against, for it produces a rocker foot.

In correcting back foot equinus it is important to bear in mind constantly the several important features of this component. The astragalus is not displaced forward and therefore does not have to be "shoved back" into the tibiofibular mortise. The astragalus never leaves this mortise in equinovarus; it merely rotates in the mortise so that its anterior end is lowered. Its position is properly readjusted in the mortise by a rotary movement that elevates the anterior end, not by a backward thrust. The calcaneus in clubfoot is retarded in the subastragalar joint and its posterior end is elevated. Correction is accomplished by pulling the back end down and by pushing the bone forward.

The ankle is grasped from the inner side with both hands, one behind and one in front. The structures are then stretched by a rotary movement in the long axis of the body. This rotary movement is clockwise for the right foot and counter-clockwise for the left foot. The actual movement cannot be described clearly and it is carried out correctly only when the operator visualizes the astragalus rotating backward in the tibiofibular mortise, the back end of the heel coming down as the Achilles tendon is stretched and the body of the calcaneus slipping forward beneath the astragalus.

Progress against equinus is made with each weekly reapplication of plaster, although it is not as rapid as that during the correction of varus. When dorsiflexion has reached the stage in which the angle between the dorsum of the foot and the leg is fairly acute, particular care must be exercised in the application of plaster in the angle. If progress in correcting equinus is slow, that is, if good dorsiflexion has not been attained in three to five months, an anesthetic should be administered so that a more accurate estimate of the contracture may be made and a cautious manipulation carried out. This may be repeated within three or four weeks. In the usual case this is not necessary and full correction can be made without anesthesia or operation.

Manipulation with the aid of anesthesia must be employed with the greatest care. It should be entirely manual, never with block or wrench, and never with any crushing force. Kite<sup>4</sup> has pointed out that when feet are placed in plaster casts for some time, the bones become soft because of calcium absorption. Manipulation of such feet with undue force breaks the articular cartilage. Further immobilization after the manipulation results in ankylosis. If the desired improvement is not gained by cautiously increased manipulation with the aid of anesthesia, the operation described in a later paragraph becomes the procedure of choice.

A check-up roentgenographic study is made at this time. Lateral views are taken with the foot dorsiflexed as far as possible. If this shows equinovarus to be satisfactorily corrected, light retention braces replace the plaster-of-Paris casts and the follow-up course which will be outlined presently is begun. If the roentgenograms reveal persistent equinus, a more radical attack is indicated so that the infant may enter the standing and walking periods with at least approximately normal feet.

When the foot of a normal infant six months of age is fully dorsiflexed, the foot should make an angle of about 45 degrees on the roentgenogram, and the long axes of the calcaneus and the first metatarsal should form an approximately straight line. If there is plantarflexion at the midtarsus, forefoot equinus persists; if there is dorsiflexion at the midtarsus, forefoot equinus has been overcorrected and a rocker foot exists. If the calcaneus is not dorsiflexed to 45 degrees, back foot equinus persists.

In 1917 Zadek and Barnett<sup>5</sup> recommended a combined achillotomy and capsulotomy for those cases of equinovarus in which there was a resistant back foot equinus. This procedure was employed on infants over one year of age. In 1933 McCauley and Krida<sup>6</sup> reported the use of this procedure in infants of six months and younger. If the forefoot has been overcorrected with a resultant rocker foot, this must be brought down in line with the calcaneus and the foot immobilized in equinovalgus for a period of one to two months to gain midtarsal stability before the operation is undertaken.

A tenotome is inserted at the inner border of the Achilles tendon just above the calcaneus, and the tendon is divided. The tenotome is then inserted into the ankle joint and the posterolateral, posterior and posteromedial capsular structures are completely severed. Care is exercised to avoid the posterior tibial artery, by pushing the vessel against the skin with the back of the tenotome before the posteromedial aspect of the joint is entered. The flexor

hallucis longus tendon is included in this section. The foot is held by adhesive in as much dorsiflexion as is consistent with free circulation, and, as it is hardly necessary to comment, the foot must be closely watched for two or three days for signs of circulatory impairment. The overcorrected, dorsally flexed position is maintained for one to two months, the adhesive being removed at weekly intervals for manipulation.

Assuming that treatment of an infant with the usual type and degree of equinovarus has been instituted immediately after birth, full correction should be gained in from four to seven months, and this includes immobilization in the overcorrected position for a period of one to two months. It is worth noting again that overcorrection implies extreme overcorrection of equinus, but only slight overcorrection of varus. The close follow-up should extend to the end of the third year, at intervals of two to three months to the end of the second year and at quarterly intervals during the last year.

The normal infant bears weight on the feet at from eight to ten months and the average infant begins to walk unaided at from fourteen to sixteen months. Ideally, the infant who is born with equinovarus should have unimpeded use of the feet at the beginning of this period. For this reason, after the seventh month, the feet should be unbraced during the greater part of the day. If, however, there is any tendency toward varus or equinus, the elastic retention braces to be described should be worn during the day. During the night, either the elastic braces or molded plaster splints may be used. Any really definite tendency to recur must be regarded as the result of inadequate correction of the original equinovarus and the feet should again be subjected to a period of manipulation and immobilization.

Elastic braces are more suitable than immobile retention braces of plaster or aluminum because they permit foot and ankle motion, and, if properly adjusted,

they assist the weaker dorsiflexors and pronators (Fig. 10). The continuous pull of the elastic ribbons tires out the stronger

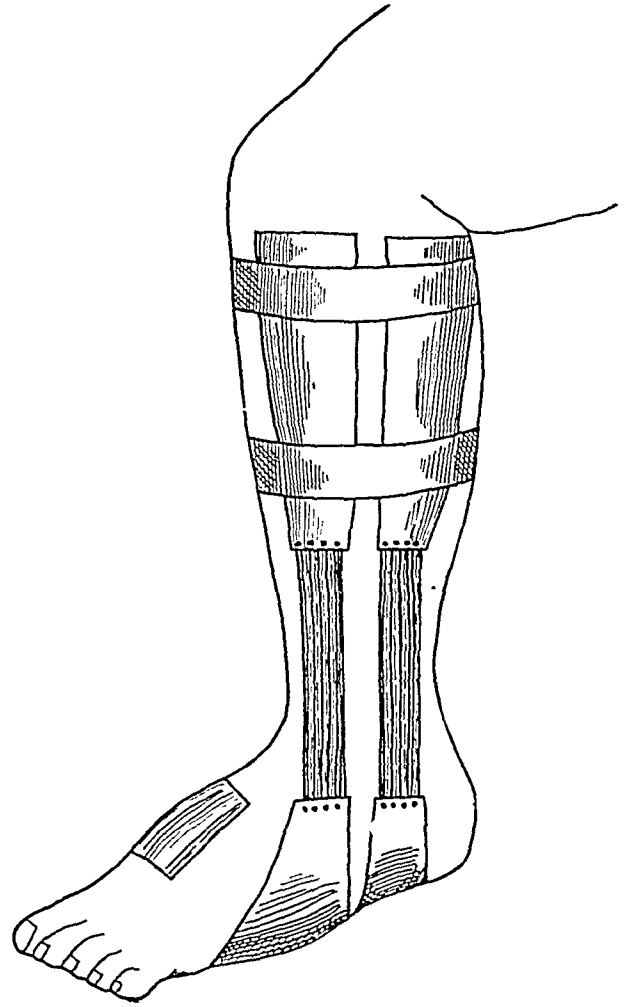


FIG. 10.—Illustrating the application of elastic retention braces.

supinators and plantarflexors. These muscles and tendons are gradually stretched, and the muscles assisted by the ribbons are allowed to shorten. This method, originally known as the "American Plan" of elastic extension, but popularized by Barwell,<sup>7</sup> an Englishman, in 1863, was used extensively and with great satisfaction by David Prince,<sup>8</sup> as he reported in 1864. The ribbons are attached to the skin by adhesive plaster, as shown in the illustration. The artificial tension of the elastic ribbons complements the weakened muscles by acting upon the same bones and in the same directions. The points from which the pull arises should be close to the origins of the weakened muscles. Thus, in assisting the dorsi-



flexors and pronators in overcoming varus and equinus, the fastening is made on the anterolateral aspect of the upper part of the leg at a point over the origins of the peronei muscles. The lower attachment imitates the insertions of these muscles, passing beneath the fifth metatarsal base and the cuboid and fastening to the inner side and dorsum of the foot. This elastic technique has an advantage over that employing an aluminum sole plate, and recently advocated by Brown,<sup>9</sup> in that it does not interfere with foot action while assisting the weakened muscles. When these elastic ribbons are used, the infant enters the standing and walking period with full use of the feet.

Such elastic braces may be worn at night or they may be removed and replaced by molded plaster splints. The skin may be kept in much better condition if the adhesive is removed for the night so that the skin may be bathed with alcohol and given a chance to breathe during the sleeping hours. The plaster splints are held in place by a roller bandage.

The operative treatment of congenital clubfoot other than subcutaneous achillectomy and capsulotomy forms another chapter. In the ordinary cases that have received proper manipulation and immobilization, it is not necessary, and it should be reserved for the neglected and maltreated cases, for the more severe cases that are often accompanied by clubhands and for those associated with spina bifida, nerve and bony defects of the limbs.

#### SUMMARY

Practically all clubfeet can be completely corrected if proper treatment is begun immediately after birth. Good results, without recurrences, are based upon a gradual reduction of the deformity through a systematic series of manipulations and a period of complete or partial immobilization extending approximately to the weight bearing age, eight months.

The manipulative attack must be directed against each of the several components of the deformity if the foot is to be restored to normal. Each of these main components, equinus, adduction-abduction and inversion, must be corrected in both the forefoot and the back foot. In equinus the back foot is plantarflexed at the ankle joint and the forefoot is further plantarflexed on the back foot. In adduction-abduction the forefoot is adducted and the calcaneus is abducted. In inversion both the forefoot and the calcaneus are inverted.

Weekly manipulations proceed systematically toward a reduction of each of these component distortions and the gain made with each manipulation is maintained by a plaster-of-Paris cast. The manipulative maneuvers are explained in detail.

If good dorsiflexion has not been accomplished within five months the closed operation for achillectomy and posterior capsulotomy is indicated so that the infant may enter the weight bearing period with unhampered feet.

For the infants in whom the contracture shows a tendency toward recurrence, elastic extension braces are indicated. These are described.

#### REFERENCES

1. WILES, PHILIP. Flat feet. *Lancet*, 2: 1089, 1934.
2. MCGREGOR, A. LEE. Congenital clubfoot: an analysis of the deformity and the principles of its treatment. *Lancet*, 2: 20, 1933.
3. BROCKMAN, E. P. Congenital Clubfoot, New York, William Wood and Company, 1930.
4. KITE, J. H. The treatment of congenital clubfeet. *Surg. Gynec. and Obst.*, 61: 190, 1935.
5. ZADEK, ISADORE and BARNETT, E. L. The importance of the ligaments of the ankle in correction of congenital clubfoot. *J. A. M. A.*, 69: 1057, 1917.
6. MCCAULEY, JOHN C. and KRIDA, ARTHUR. The early treatment of equinus in congenital clubfoot. *Am. Jour. Surg.*, 22: 491, 1933.
7. BARWELL, RICHARD. The Treatment of Clubfoot without the Division of Tendons, London, 1863 (quoted from Prince).
8. PRINCE, DAVID. Orthopedic Surgery, Transactions, Illinois State Medical Society, 1864, p. 62.
9. BROWN, LLOYD T. The treatment of clubfeet. *Jour. Bone and Joint Surg.*, 18: 173, 1936.

# INGROWN TOE-NAIL\*

J. J. KIRSCHENMANN, M.D.

Associate Surgeon, Norwegian Hospital

BROOKLYN, N. Y.

**I**NGROWN toe-nail is a common condition where dirt, sweat and irritation meet and it is doubtful that the trimming of a toe-nail in any particular fashion is the causative agent. However, when tight shoes, perspiration, uncleanness or friction unite and set up a local irritation of the skin allowing invasion of bacteria, a so-called ingrown toe-nail may result. In the first stage there is simple inflammation of the nail-wall with swelling and redness causing what appears to be an embedding of the lateral nail-edge. In the second stage this inflammatory condition continues to suppuration. In the third stage the suppuration of the nail-wall progresses and burrows under the nail-body and root.

It is with this second and third stage that I will specifically deal. In the second stage excision of a small wedge will probably cure the condition but recurrence is common. In the third stage excision of a wedge is rarely satisfactory unless part of the nail and growth matrix are also removed. This operation is unsatisfactory in the hands of many men; it leaves a deformed toe and nail which is unsightly, and frequently a small piece of growth matrix is left from which spicules of nail grow and cause constant irritation.

In 1932 a girl presented herself with an ingrown toe-nail that required radical surgery. Due to the fashion of going stockingless she refused excision of part of her nail-bed as she felt it would interfere with her appearance when she exposed her polished nails. In overcoming her objections I performed a slightly different type of operation which has been satisfactory in over 100 cases without recurrence.

Operation is done under local novocain and a rubber band at the base of the toe. The extent of the inflammatory condition

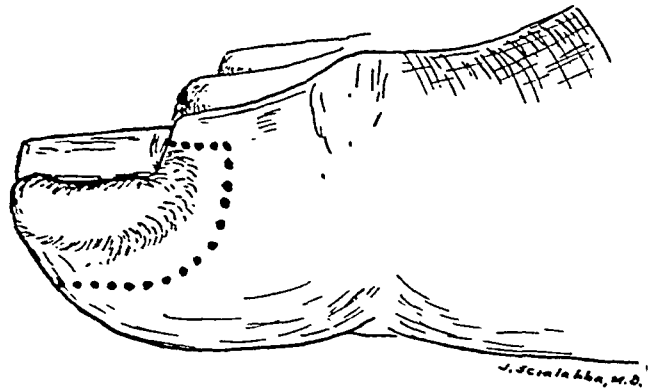


FIG. 1. Lateral view showing incision in nail-wall.

across the nail-root is taken into consideration and an incision  $\frac{1}{4}$  inch long is made in the skin down to the nail-root at a point where the maximum swelling just ceases (Fig. 1). The incision is then carried laterally and downward to the level of the lower third of the side of the toe. It is then carried forward at this level to the end of the toe. The depth of this incision is about  $\frac{1}{4}$  inch. A pointed scissors is then inserted under the free end of the nail at such a point as to meet the incision in the nail-bed and the nail cut. The cut portion of the nail is then grasped with a hemostat and lifted out of its bed. The nail-wall is then held back with a thumb forceps while the scalpel cuts down along the nail sulcus to the level of the incision in the lower third of the side of the toe (Fig. 2). If the incisions are properly placed a block of tissue is freed which lifts out except at the nail root where it must be freed being careful not to injure the growth matrix. Bleeding is rare. Before packing with iodoform gauze the rubber band is cut and all bleeding controlled. The packing is left

\* From the Out Patient Service of the Norwegian Hospital.

in place for forty-eight hours and repeated for one week. When the slight sloughing has discontinued the wound is stimulated

be flat and there might be a possibility of recurrence in the new formed nail-wall. The nail grows back in four to six

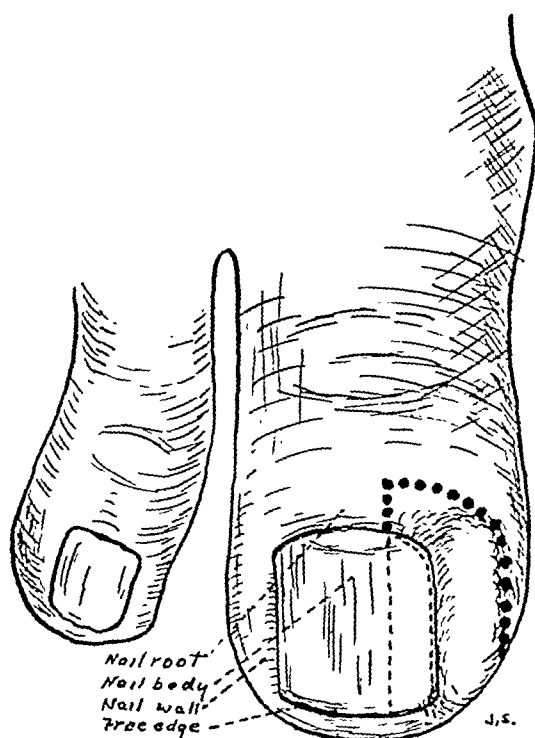


FIG. 2. Dorsal view showing incision in nail-bed and nail-wall.

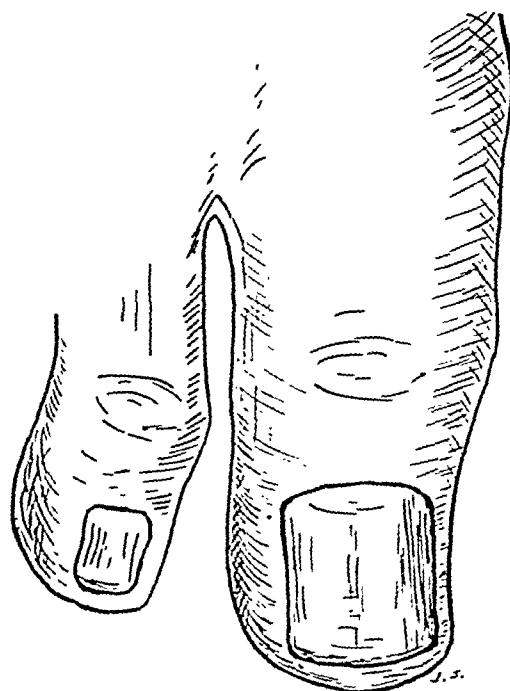


FIG. 3. End result showing flattening of nail-wall.

with balsam of Peru. Granulations form very rapidly and must be fought down constantly so that when the wound is completely healed this side of the toe is flat with no visible nail-wall (Fig. 3). I feel that the fighting down of the granulations is a very essential part of the operation. If not properly done the side wall will not

months and the aesthetic patient is most appreciative.

#### SUMMARY

A satisfactory operation for the cure of an ingrown toe-nail that can be performed by the average man with uniformly good result had been presented.



# HAMMER-TOE AND CLAW FOOT

KENNETH H. SCHNEPP, M.D.

Attending Surgeon, St. John's and Springfield Hospitals

SPRINGFIELD, ILL.

IT would be difficult to find a more descriptive term than hammer-toe, for so it is, at least in shape. When several toes are involved, and if associated with an abnormally high arch, it is spoken of as claw foot.

More scientifically, if less picturesque, hammer-toe is a characteristic joint deformity (Fig. 1), in which the proximal phalanx is hyperextended at the metacarpophalangeal joint, acutely flexed at the proximal phalangeal joint, and either extended or flexed at the distal phalangeal joint. Not infrequently, the toe is dislocated upward at its junction with the metatarsus, with concomitant alterations in the joint capsule and ligaments. Even in the absence of luxation these changes are present and may be accompanied by arthritic or other osteoplastic changes in the epiphyses. All such changes in joint capsule, ligaments and epiphyses are secondary to the deformity and the deforming cause.

The peculiar shape of the toe in relation to the footwear often produces distressingly painful corns, callouses and thickened bursa on the knuckle of the proximal joint and at the tip, the latter including a deformed nail. Tender ulceration and callus, however, may appear at any point of constant pressure.

For such a common deformity, surprisingly little has appeared in the literature concerning the etiology; it is usually dismissed, in the average orthopedic text, with a few brief words on treatment. This obviously creates the impression that a routine therapy is available for all such toes, which is certainly not the truth, nor does such an impression convey the surprising individual variations which may occur, and do accompany, such deformities.

Hammer-toe may be congenital but this is undoubtedly rare. It often accompanies bunion (hallux valgus), in which case the second digit is usually involved. It is more frequent in the female, possibly because of the higher incidence of hallux valgus in this sex. One may find hammer-toe in what is essentially a "normal" foot, these cases usually involving the fifth and, in the majority of these, undoubtedly deformed by direct pressure of footwear.

In the past much stress was placed upon footwear as a deforming agent. While true that certain applied pressures are capable of causing almost any type of malformation (witness the bound feet of Chinese women), it is also probable that ill-fitting footwear of itself, in the absence of defective inheritance, balance, gait or weight distribution, would cause few serious deformities.

In certain instances of pes cavus or high arch, multiple hammer-toe occurs. These are essentially indistinguishable from other hammer-toes accompanying other deformities. The combination of pes cavus with hammer-toe has been given the name of claw foot, and perhaps unfortunately, because high arch is quite frequent without toe deformity. The term "claw foot" wrongly implies the same mechanism for both the distorted arch and the deformed toes.

The fact that hammer-toe occurs, independent of, or seemingly in spite of various other deformities but serves to emphasize its own peculiar etiology. Unfortunately, this latter has been confused and entangled with the etiology of flat-foot, hallux valgus, pes cavus, and certain other malformations when the association of these may be causal to a limited extent, but is not the fundamental disfiguring force.

The only clues obtainable from a study of accompanying deformities lead to negative evidence. A well deformed second

for a second or multiple hammer-toe. These are often seen, with large painful corns and bursa, on both the tip of the toe and the dorsal surface of the proximal joint. It is blithely stated that these painful accompaniments are the result of pressure from below and above respectively, with a total disregard for the fact that this same pressure should prevent the formation of a hammer-shaped toe.

Lake<sup>1</sup> explains the occurrence of hallux valgus and the separation found between the heads of first and second metatarsals as a result of explosive strain at this point during the moment of take-off. This may or may not be true. However, he extends this same theory of take-off strain to explain hammer-toe and assumes that as the foot rises for the take-off, the head of the first metatarsal, with the bolstering effect of the sesamoids, rotates about the center of the metatarsal head. The other metatarsal heads, however, roll forward. Assuming that the tip of the toe remains fixed, this would most certainly produce the characteristic extensorflexion position of hammer-toe. The secondary piling up and hypertrophy of the soft tissues are supposed to increase the deformity further.

There are many objections to this theory. First of all, the deformity of hallux valgus, in itself, is certainly not the cause of hammer-toe. Even if the explosive strain of the take-off is the cause of hallux valgus, and there is debatable ground here, this is no reason for ascribing hammer-toe to the same mechanism. Secondly, the deformity of pes cavus, in itself, is not the cause of hammer-toe. Furthermore, hallux valgus is unusual with pes cavus. Thirdly, in claw foot, and other well developed conditions of hammer-toe, a normal take-off does not usually exist. The toes, especially the more deformed ones (Fig. 2), seldom bear weight. The patient very definitely does not roll forward, and claw foot will steadily become worse without toes ever touching ground; the forefoot is placed flat to ground and a characteristic "stilt-gait" often can be recognized.

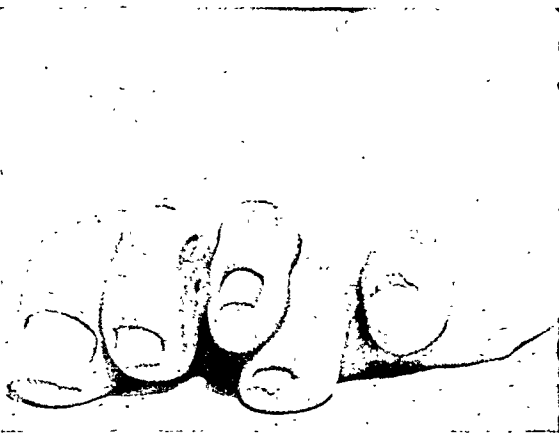


FIG. 1. The typical hammer-toes of a claw foot showing pressure points. This is the position of the toes as the foot bears weight.

hammer-toe accompanying hallux valgus or flat-foot presents the same anatomical picture as does a hammer-shaped fifth toe in an otherwise normal type foot, or three or four such toes accompanying pes cavus. One can assume from this that the hallux valgus, flat-foot, or pes cavus is not the cause, *per se*, of the toe deformity. But, on the other hand, it is difficult to say that these associated conditions are not in some way related to the toe deformity, since there is no reliable information available, taken from random sampling of "normal" and "abnormal" feet, to afford a means of correlation.

It must be emphasized that in hammer-toe we are dealing primarily with a *joint deformity* and that bony and capsular changes are secondary. The forces which can alter the relationship of the bones meeting to form a joint are trauma, external pressure, paralysis of certain muscles, and inflammation with contracture or spasm. Traumatic hammer-toe is quite rare. External pressure is always a potent consideration and this seems to account particularly for the frequency of the fifth hammer-toe in the female utilizing certain modern footgear. Unfortunately, the same line of reasoning fails to account entirely

The question of transient muscle paralysis or weakness has been advanced from time to time.<sup>2</sup> It has been pointed out

been confirmed and there is other contrary evidence.

The doctrine of contracture following



FIG. 2. X-ray picture and pedograph of claw feet. Note the high arch, varus tendency of the heel, and the inversion of the forefoot. Since the pedograph was made during locomotion, it will be seen that the toes bear little weight or none at all.

that the interossei normally flex the first phalanges of the toes and extend the last two. If a transient paralysis and permanent weakness of these muscles is conceded, the unopposed extensors could cause hammer-toe, and, since the interossei center around the second digit, this must be given serious thought considering the frequency of a second hammer-toe. The only trouble with this theory is that such weakness has never

inflammatory changes in the sense of an ischemic contracture or that of Dupuytren is attractive but it will not bear analysis. The etiology is missing and so are the characteristic anatomical changes.

The question of spastic contraction of the flexors and extensors of the toes is quite another story. Much evidence has been accumulated to show that states of increased tonus can be followed by typical

hammer-toes even while the patient lies in bed without bearing weight. These have been repeatedly observed in Friedreich's

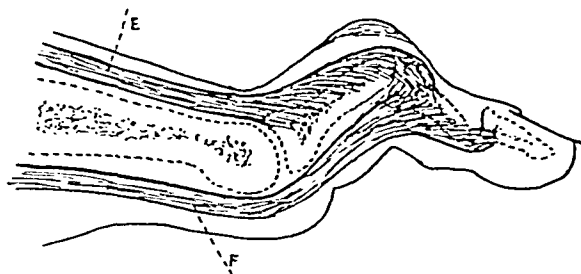


FIG. 3. Because of the peculiar insertion of the long flexor, F, and extensor, E, tendons, a preponderant, simultaneous pull on each will cause the typical hammer-toe position.

ataxia, Wilson's disease, spinal cord tumors, poliomyelitis, and other central nervous system conditions.

It has been recognized, that, given the normal mechanics of a toe, tension on the long flexor tendon and long extensor tendon, exerted simultaneously, will produce a typical hammer-toe as shown by Figure 3. An analysis of these feet during locomotion, or of spastic feet, clearly reveals the tense extensor tendons. Yet it is not a case of contracture, except possibly in the extreme cases, because most of the toes may be straightened too easily. The tension on these tendons is functional, particularly in the earlier stages.

Although it requires very little imagination or proof to visualize the formation of hammer-toe in a spastic limb by excessive simultaneous contraction of the flexors and extensors, this, apparently, does not explain their presence in a weight bearing foot that is not paralyzed or, as nearly as we can tell from the history, never was paralyzed.

The answer is, I believe, to be found in the excessive weight bearing of certain metatarsal heads. It is an axiom of the foot that long continued excess weight bearing will lead to hypertrophy and increased density of bone, particularly in the metatarsal heads. "Characteristic function and destructive structure go hand in

hand."<sup>3</sup> It is also axiomatic that points of increased pressure and weight bearing develop callosities. It will be found that in a surprisingly large percentage of hammer-toe, the corresponding metatarsal shows these changes and the weight bearing area under the head is the seat of callouses and tender tissue. The metatarsal pain and tenderness, usually present, finds expression in the extent to which metatarsal bars are used in treatment. As shown in the case illustrated in Figure 1, the callus occurs most frequently under the more deformed toes. But as a matter of fact, it is a recognition of this excess weight bearing on the head of the metatarsal which led Lake to evolve his theory of take-off strain.

Saxl<sup>4</sup> has recognized the relationship of inflammatory transverse flat-foot to hammer-toe but ascribes the toe deformity to relative insufficiency of the interossei and lumbricales with a resultant functionally preponderant extensor. This may be an occasional factor but meets with the same objections which tend to nullify the theory of transient paralysis or chronic weakness.

A still further analysis of certain cases convinces one that this functional tension is an attempt on the part of the individual to remove painful pressure from the metatarsal head. Except for the extensor digitorum brevis, there is no constant mechanism for dorsiflexing the metatarsal heads themselves; it is a fact that only the extensor hallucis brevis has a metatarsal insertion, the remaining heads of the extensor digitorum brevis most frequently inserting into the bases of the proximal phalanges of the second to the fifth toes and blending with the extensor digitorum longus to aid the latter in dorsiflexing the toes.

In the event that a metatarsal head becomes painful, there is no mechanism available for relieving its weight bearing function through a dorsiflexing action except by the poor substitution of hyperextended toes. It is an effort on the part of the foot to withdraw the metatarsal head from intolerable pain—it is a position of relief.

Certainly other deforming factors cannot be overlooked, such as, the valgoid position of the great toe in bunion or the pressure of ill-fitting shoes, but these are incidental factors only.

The patient whose feet are illustrated in Figures 1 and 2, affords an unusual opportunity to study the development of hammer-toe over a relatively short period of time.

CASE 1. The history, in brief, is that of a white male, thirty-two years of age, whose early history is negative except for pneumonia at five months and typhoid fever at five years. There was no known poliomyelitis or other nervous system lesion. He had always had high arch, but suffered no pain or disability. During university matriculation in 1923, the high arch was noted and he was placed in a special foot corrective gymnasium class. No hammer-toe was ever detected until the onset of rheumatic fever in the fall of 1929. Although beginning in the fingers and ankles, the process later involved the foot and particularly the forefoot. For over three years he had recurrent attacks of arthritis involving the metatarsal heads without any of these ever quite receding to a normal state. During this period, walking was very difficult, and, at times, impossible and at no time was the forefoot ever able to bear full weight. By 1932, the toes were much as they are shown in Figure 1. The metatarsal heads are still painful on extended walking and a bar is worn constantly. All toes, even the luxated fifth toes, can be straightened, some, however, requiring tension. The foot itself is not rigid but pes cavus is more pronounced now than it was ten years ago. As noted by the x-ray picture and the pedograph (Fig. 2) evidence of the active process has disappeared.

#### CLAW FOOT

Claw foot is the descriptive name commonly applied to a combination of high arch (pes cavus) and multiple hammer-toe. Pes cavus varies considerably in extent and degree but its characteristic feature is a high arch, created primarily by a lowering of the forefoot, this occurring most often at the astragaloscaphoid articulation. The result is a foreshortened foot with reduction in treading surface, prominent metatarsal

heads, and shortened plantar structures. In more advanced stages the foot loses flexibility and it becomes impossible to passively raise the metatarsal head with a resulting correction of the deformity. Dorsal flexion may be limited but this is usually the result of dropped forefoot and not a contracted Achilles tendon. Progressively, the deformity may increase, with, oddly enough, calcaneal varus combined with eversion of the forefoot, rigidly contracted hammer-toes and much pain and disability. Extreme cases present an exaggeration of all factors with absolute incapacity.

The cause of pes cavus is uncertain. It is easy to understand why an arch will flatten under the influence of superimposed body weight; it requires considerable ingenuity to explain a progressively elevating arch under the same conditions of weight bearing.

The most satisfactory explanation considers the actual origin of pes cavus as a functional neuromuscular imbalance. For whatever reason, one or more of the elevators of the longitudinal arch (flexor digitorum longus, flexor digitorum brevis and posterior tibial) become functionally preponderant over the extensors of this arch (calf muscles, toe extensors and peroneal muscles). This disturbed balance of power with a surplus in favor of a lowered forefoot, if persisted in for long, is followed by secondary contraction of plantar structures and finally to such bony changes in the midfoot that flattening becomes physically impossible. The cause of this functional neuromuscular imbalance may be varied and includes many lesions of both the foot and the nervous system. The retracted toes are but the expression of an effort to raise the metatarsal heads through the medium of the toe extensors.

For more extended reviews of this subject consult Mills,<sup>5</sup> Stuart,<sup>6</sup> Steindler,<sup>7</sup> Goff,<sup>8</sup> Parker,<sup>9</sup> Royle,<sup>10</sup> and Saunders.<sup>2</sup>

#### TREATMENT

Something may be accomplished in a preventive sense during the early stages of



hammer-toe and claw foot. Naturally, shoes should be designed to fit the foot and high heels avoided. But this is not suffi-

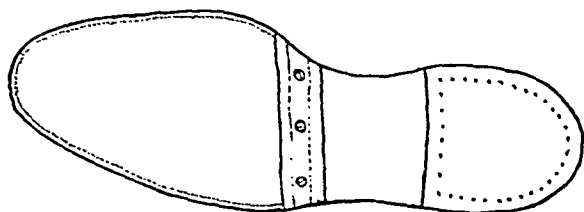


FIG. 4. Illustrating the position on the shoe of a metatarsal bar.

cient. Hammer-toe, itself, can be passively manipulated and the accompanying metatarsal head raised by padding. Plantar corrective plates have been devised, these to be worn at night. The average patient kicks them off because of discomfort. Associated flat-foot must be treated through posture reeducation, supports, exercise and alterations in locomotion. Hallux valgus of any degree yields poorly to any but surgical therapy.

In certain adolescent cases of high arch, the feet must be watched closely. Low or no heels at all help somewhat. A metatarsal bar is useful and, in many cases, provides surprising relief when affixed to the shoe about an inch behind the metatarsal heads parallel to their line. A properly designed bar (Fig. 4) is at least  $\frac{3}{8}$  inch in thickness. If a shortened Achilles tendon is found, and this is not too common, stretching under anesthesia followed by the application of a plaster cast with the corrected foot in dorsal flexion is effective. Passive correction and wrenching of early *pes cavus* seems to result in recurrence in a majority of instances. One must also keep in mind Goff's<sup>9</sup> experience with the *pes cavus* of congenital syphilis and exclude this as an etiological factor.

In probably no other surgical sphere must treatment be so highly individualized as in deformities of the foot. It is true that gross similarities in certain malformations have engendered standardized procedures but it cannot be too strongly emphasized that procedures to be collectively successful

must be individually selected and extensively, even radically, carried out. We have seen that hammer-toe is frequently a complication of other foot deformity and usually takes but a part in the "custom-therapy" which is so important in these cases.

Hammer-toes<sup>12</sup> may be amputated but this is not always desirable lest the resulting deformity create more disability than the original toe. In case the neighboring toes are too rigidly in juxtaposition, or the distal nail portion badly deformed, it may be a useful procedure when combined with other methods. There is probably no better way than amputation for dealing with a fifth hammer-toe if one is careful to leave a thick pad of tissue to cover the metatarsal head. Resection of the terminal phalanx or the proximal phalanx alone has been advocated and is probably useful in isolated instances.

Tenotomy, alone, of flexor and extensor tendons has been advised. This, of course, leaves a flail-toe which is less of a disadvantage than one would imagine in a shoe-wearing race. There are more physiological methods however.

The common operation is that of interphalangeal arthrodesis,<sup>13</sup> the object being to provide firm bony union between the proximal and middle bones of the toe. Fibrous union is unsatisfactory in that the toe re-forms and is painful under stress. To accomplish a good result an elliptical incision completely excises the knuckle of the toe, taking with it corn and bursa, and the dorsal extensor tendon is severed to allow ready access to the joint. The head of the proximal bone is excised completely and with it the joint bearing surface of the second phalanx together with the joint capsule as illustrated in Figure 5. This should be sufficient to allow full correction of the deformity. It is unnecessary to disturb the lateral digital arteries. The wound is closed with non-absorbable sutures and a firm dressing applied. The toe may be bandaged in corrected position to a plantar splint or to the neighboring toes until bony

union is secure. Trethowan<sup>14</sup> uses a small collodian gauze bandage, which is kept in place for two weeks and after this period

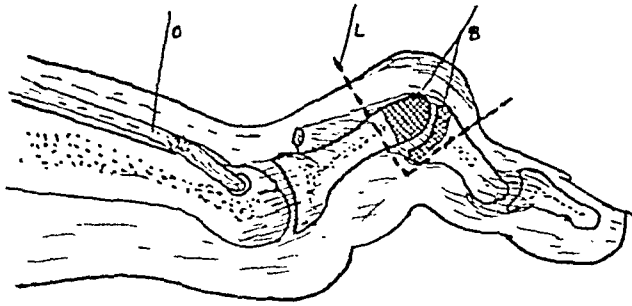


FIG. 5. Schematic illustration of the method of arthrodesis used in hammer-toe. O, optional transplantation of long extensor tendon; L, line of skin incision; B, bone to be excised.

the sutures are removed. Following this, splinting must be used as above.

Higg's<sup>1</sup> modification, in which the proximal phalanx is sharpened to a point and inserted into a corresponding depression hollowed out of the second phalanx, is said to afford a more secure splinting. With the extensor tendon, Jones severs the flexor tendon; this might be advisable in some cases but is usually unnecessary if complete excision of the joint is done. Often, much good is accomplished by transplanting the extensor tendon to the metatarsal head as described under the treatment for claw foot.

If hallux valgus or flat-foot is present, these must be corrected if possible at the same time. These procedures have been described by others and will not be reviewed here.

The correction of claw foot has always been difficult because of its tendency to recurrence. At the present time, the moderate and more severe grades are treated rather radically, and necessarily so. In general, there are two problems to solve: the shortened plantar structures and the dropped metatarsal heads. Whether either or both are corrected depends upon the degree of deformity.

In mild cases, in which the deformity disappears on standing, it may be enough to manipulate the forefoot with a Thomas wrench while under a relaxing anesthetic.

This is done in such a way that acute flat-foot is induced. The foot is placed in plaster in a position of marked dorsal flexion and



FIG. 6. Steindler's operation for division of contracted plantar structures; S, subperiosteal stripping of os calcis.

maintained for two weeks. Following this, shoes are worn with very low or no heel and with a metatarsal bar (Fig. 4).

In severer grades of claw foot more radical procedures are necessary. In dealing with the contracted plantar structures, Steindler's<sup>8</sup> operation is the most satisfactory. A curved incision is made on the inner aspect of the heel about  $\frac{3}{4}$  inch above the plantar surface (Fig. 6). It extends from the back of the heel to a point well in front of the anterior process of the os calcis. By blunt dissection all structures are stripped subperiosteally from the undersurface of the os calcis and the plantar fascia and small muscles of the foot are thus freed at their insertions. This is extended transversely and includes the calcaneocuboid ligament. This should be followed by a flattening manipulation, after which the incision is closed with two layers of suture. Any considerable oozing may be controlled with hot packs.

The next problem is management of the dropped metatarsal heads. Most moderate cases are adequately treated by transplanting the extensor tendons to the metatar-

## Schnepf—Hammer-Toe &amp; Claw Foot

sal heads<sup>15</sup> in the following procedure. A longitudinal incision is made over the first metatarsophalangeal joint and extended

of the fifth metatarsal. The long extensor tendons are severed and transplanted in the same manner as the extensor hallucis

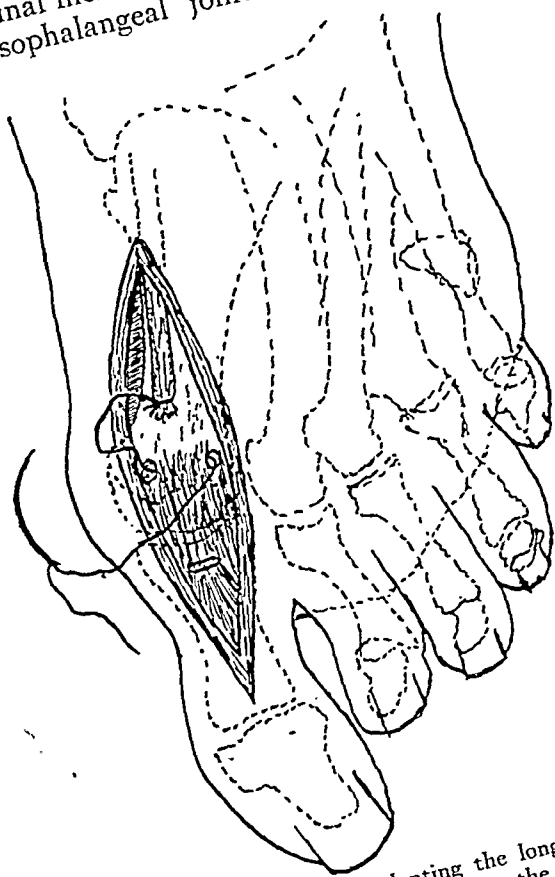


FIG. 7. Method of transplanting the long extensor tendon from the proximal phalanx to the metatarsal head.

to the interphalangeal joint. The extensor tendon is divided at its insertion into the proximal phalanx. With an assistant providing plantar pressure on the metatarsal head, a tunnel is created transversely, usually by drilling from each side to a common midpoint. The tendon is threaded through this with a silk suture on a slightly curved needle and pulled up sharply (Fig. 7). It is sutured with this silk to the proximal portion of tendon to form a loop. Interphalangeal arthrodesis is then done by an excision of the articular surfaces and the incision closed.

Next an incision is begun over the head of the second metatarsal, carried in a transverse direction across the other metatarsal heads and curved slightly over the shaft

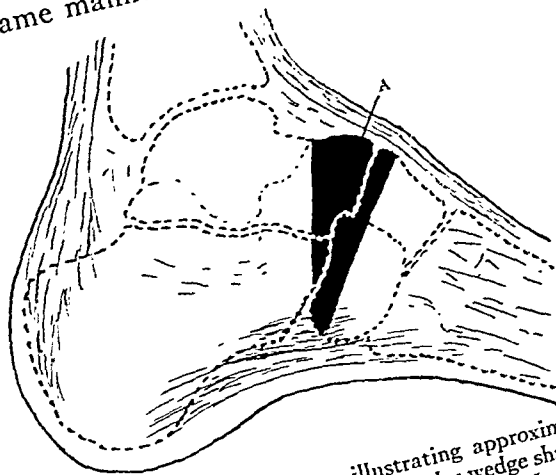


FIG. 8. Schematic diagram illustrating approximate average amount of bone removed by wedge shaped excision in severe claw foot or where ankylosis of the midfoot is desirable; A, area of resection.

tendon. At this time, if the subluxated toes do not readily return to a more normal position, capsulotomy may be necessary as advised by Heyman.<sup>16</sup> This is a simple transverse incision of the contracted dorsal aspect of the metacarpophalangeal joint capsule. The skin incision is closed and the foot put up in plaster in the corrected position. After two weeks, walking in plaster is permitted and finally shoes with a metatarsal bar are employed.

In the event that it is thought necessary to correct a midtarsal angulation—the result of marked bony changes—several procedures may be done depending upon the point of angulation.

Osteoclasia of the shafts of the first and second metatarsals near the base has been utilized. This has the advantage of correcting bony deformity to a certain extent without shortening the foot and without losing flexibility. However, in probably a majority of patients, the deformity will be found to occur at the astragaloscaphoid articulation. Besides, in all instances associated with definite paralysis or muscle weakness, it is highly desirable to ankylose the midfoot, at least in part. Consequently, a cuneiform osteotomy is done as illus-

trated in Figure 8. After retracting the tendons, a wedge shaped piece of bone is removed from the neck of the astragalus in sufficient quantity to correct the distorted arch fully. The osteotomy is then extended laterally through the cuboid or the anterior process of the os calcis as desired, these being easily exposed by further retraction of the tendons. The foot is retained in corrected position by a plaster cast until ankylosis is firm. This is usually six to eight weeks.

In extreme instances of pes cavus, Jones<sup>17</sup> advises preliminary astragalectomy followed by amputation of the toes and heads of the metatarsals. Fortunately, these cases are infrequent.

#### CONCLUSIONS

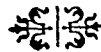
1. Hammer-toe represents an attempt, on the part of the extensors of the toes, to raise the metatarsal heads. It may be a functional spasticity of central nervous system origin. It may also be secondary to a painful metatarsal head, in which case it is to be considered a position of relief.

2. Claw foot is a deformity characterized by high arch, lowered forefoot, contracted plantar structures, and multiple hammer-toes. It is to be considered the result of functional neuromuscular imbalance from whatever cause in which the balance of power is in favor of the flexors of the longitudinal arch.

3. All deformities of the foot require individualization in treatment. To be successful, operative procedures must be considered collectively and carried out, if possible, at one time. Claw foot therapy in particular must be radical to be successful.

#### REFERENCES

1. LAKE, NORMAN C. The Foot. Baltimore, Wm. Wood & Co., 1935.
2. SAUNDERS, J. T. Etiology and treatment of claw foot. *Arch. Surg.*, 30: 179, 1935.
3. MORTON, D. J. Mechanism of normal foot and flat-foot. *Jour. Bone and Joint Surg.*, 6: 368, 1924.
4. SAXL, A. Hammer-toe and transverse flat-foot. *Ztschr. f. orthop. Chir.*, 63: 154-160, 1935.
5. HIBBS, R. A. An operation for "claw foot." *J. A. M. A.*, 73: 1583, 1919.
6. MILLS, G. P. Etiology and treatment of claw foot. *Jour. Bone and Joint Surg.*, 6: 142, 1924.
7. STUART, F. W. Claw foot—its treatment. *Jour. Bone and Joint Surg.*, 6: 360, 1924.
8. STEINDLER, A. Operative treatment of pes cavus. *Surg., Gynec. and Obst.*, 24: 612, 1917; and The treatment of pes cavus. *Arch. Surg.*, 2: 325, 1921.
9. GOFF, C. W. The pes cavus of congenital syphilis. *J. A. M. A.*, 86: 392, 1926.
10. PARKER, C. A. Hollow-foot, pes cavus. *J. A. M. A.*, 61: 1886, 1913.
11. ROYLE, N. D. Claw foot. *Jour. Bone and Joint Surg.*, 9: 465, 1927.
12. CREER, W. S. Treatment of hammer-toe. *Brit. Med. Jour.*, 1: 527 (March 16) 1935.
13. JONES, R. Hammer-toe. *Brit. Med. Jour.*, 1: 782 1916.
14. TRETHOWAN, W. H. The treatment of hammer-toe. *Lancet*, 1: 1257, 1312 (June 20) 1925.
15. FORBES, H. M. Claw foot and how to relieve it. *Surg., Gynec. and Obst.*, 16: 81, 1913.
16. HEYMAN, C. H. The operative treatment of claw foot. *Jour. Bone and Joint Surg.*, 14: 335, 1932.
17. JONES, R. Claw foot. *Brit. Med. Jour.*, 1: 749, 1916.



# SIMPLE TREATMENT FOR PUNCTURE WOUNDS

E. G. FESTERLING, M.D.

MILWAUKEE

THE designation "puncture wound," immediately brings to mind a wound, small on the surface but of variable depth, and most common in the sole of the foot. In this situation, as everyone knows, the offending nail protrudes vertically upwards from a board, unnoticed by the unwary pedestrian. In some cases the foot is actually transfixed by the nail or spike. The next most common site is the palm of the hand; less frequently in other situations. Other vulnerating agents may be the culprits, as in impaling injuries, in falls astride a sharply splintered broken board, but typically, when puncture wounds are thought of, the offending object is a nail or spike.

It has been the accepted teaching of bacteriology for over a generation that it is impossible to produce tetanus in an experimental animal by the injection of a pure culture of *Bacillus tetani*, the tetanus toxin having been excluded. The tetanus organism, being an anaerobe, will not flourish in pure culture in the living tissues for the blood stream furnishes a sufficient supply of oxygen to inhibit its growth and multiplication. Some factor which eliminates this inimical oxygen supply is needed if clinical tetanus is to ensue, and in the natural state, this is usually a contaminating common pus producer. These facts are well known to the surgeon; he accepts their teachings on Sunday, but in his practical work on Monday, he wavers and loses the courage of his convictions, his defenseless patient gets "the works" and reaps the results thereof as indicated below. Clearly then, preventing tetanus in a puncture wound accidentally acquired becomes a matter of preventing pyogenic infection, which should be done in any event, and is an extremely simple matter.

For about a quarter of a century, after having noted the dissatisfaction and impracticability of treating such lesions by free incision, the giving of antitetanic serum, etc., as directed by our highest authorities and authors of standard texts, I have used the simple method described below to the exclusion of all other methods, with entirely satisfactory results and no regrets. The chief difficulty was the painfulness of such procedures and the consequent lack of enthusiasm for them by the patient, which resulted in poor cooperation. If such treatment were universally carried out, probably 50 per cent of patients now treated professionally would shun the doctor and place their faith in grandma's flaxseed poultice, or "rattlesnake oil" supplied by the itinerant vender.

## TECHNIQUE

It is assumed that the wound is a recent one, that is, not over twenty-four hours old. In wounds much older than this, and in cases where infection is fully developed, to speak of prophylactic treatment is of course meaningless. After simple cleansing, the wound is probed to determine its depth and the presence or absence of foreign bodies, which are removed if present. A strand of silkworm gut is now boiled, doubled at least twice (except for the smallest wounds) and introduced to the bottom of the wound and withdrawn not more than  $\frac{1}{4}$  inch. The protruding end of the drain is bent at a right angle and fixed by means of adhesive securely to the skin surface close to the edge of the wound. The drain is withdrawn slightly every day or every other day, and by the fifth day, may in the majority of cases be finally removed. A simple gauze dressing completes the treatment. Rest is enjoined.

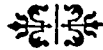
Wounds treated in this manner will not develop tetanus or any other infection if an experience of twenty-five years with it is any criterion.

The objections to the use of antitetanic serum are quite well known but may be briefly stated. (1) In patients sensitive to horses, a violent anaphylactic shock sometimes lethal, will result in a few minutes, an eventuality still sometimes unheard. Besredka's method of desensitization is unsuited for office use and bovine sera are generally not available. (2) The anaphylactic state, if not present, may be produced by a single injection, to plague the patient and his attendant at some future date. (3) Even in the absence of an immediate severe reaction, the patient

usually spends a sleepless night unless generous use of narcotics is made, and, (4), but least important, the matter of expense.

#### CONCLUSIONS

The treatment of puncture wounds can be made very simple. Silkworm gut is the perfect drainage material. It does not swell and so does not act as a plug. A proper esteem for efficient drainage in accidentally produced puncture or other wounds will be revived in the practitioner who is called to resume the treatment of such wounds after someone has sewed them tightly in the first instance. This writer has seen some well-nigh disastrous results following such treatment.



# PARONYCHIA

G. MASON ASTLEY, M.D.

Associate Professor of Surgery, Temple University

PHILADELPHIA

**A**S here employed the term paronychia refers only to those infections which start in the skin lateral to the finger

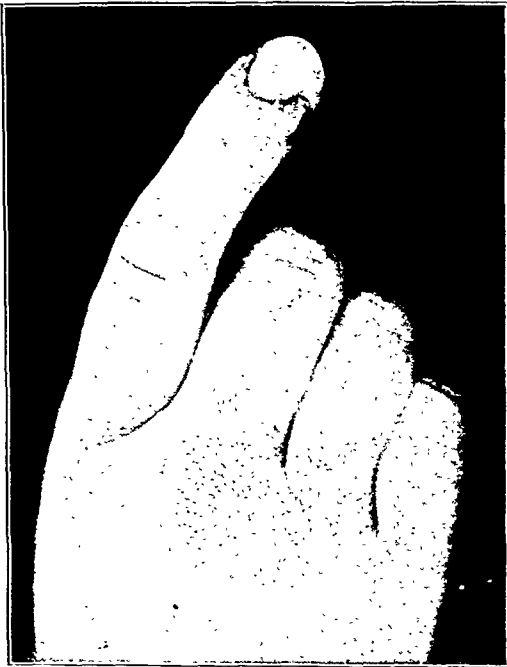


FIG. 1. Untreated paronychia. (Kanavel, Infections of the Hand. Phila., Lea and Febiger.)

nail, and which, unless aborted by active natural resistance or by surgical treatment, tend to spread by way of the eponychia to the other side of the nail. A shorter, and perhaps clearer, statement would be that it refers only to the infections commonly known as "run-around" or "ring-around" (Fig. 1).

Fortunately for mankind the potentialities for development of these infections into life-threatening, or permanent finger-disabling processes are not great and in no way comparable to the dangers of the infections of the pulp of the finger. On the other hand these infections may be temporarily disabling to a considerable degree, depend-

ing largely on the occupation of the victim, and for a period of time, out of all proportion to the actual damage of the infection.

The severity of the suffering and the duration of the disability from these infections, as is so often the case in other conditions, depend on the promptness with which efficient treatment is applied. Responsibility for delay may rest with the patient, who has applied home remedy until no longer able to endure the discomfort; or, unfortunately, with the physician, who has either not grasped the significance of the situation, or may have been unwise enough to continue insufficient treatment on the patient's refusal to permit the indicated incision.

Such infections may have their origin in recognized trauma or may develop in the entire absence of any visible break in the integument. The well known "hangnail" or "stepmother" is a rather common entrance point of infection. Other, unfortunately not infrequent sources of infection entrance, are the small traumatism sustained during manicuring.

The anatomic structure of this part of the finger is such that, excepting in the rapidly spreading cellulitis types of infection, resulting from streptococcus implantation, the inflammatory process in paronychia remains limited to the immediate neighborhood of the lateral margins of the nail, and the proximal part of the nail-bed. The more serious aspect develops when the inflammation extends to the tissues beneath the nail at its base. Under these circumstances pain becomes exquisite, and continues so until pus discharge occurs; and the period of local disability, even though pain relief may be almost complete after pus discharge, is of six to twelve weeks duration.

The bacteria responsible are the common pyogenes, *Staphylococcus aureus* and *albus* in particular.

A chronic variety of paronychia is at times seen in which over a period of months there is injection and thickening of the eponychium with an unsightly, red, elevated area of skin bordering the nail. At times there is discharge of small droplets of pus from beneath the eponychium, and it is the seat of constant discomfort of varying intensity. It is quite certain that this type of paronychia is largely occupational in its causation being more commonly seen in florists, bakers and laundresses.

The therapy of the two forms is entirely different. Because the more common form is that first mentioned, and because the "family" physician is the one usually first consulted, it will be given first consideration.

The basic principles of treatment, namely, establishment of drainage and its maintenance are the same as for treatment of local infections elsewhere. The details suggested are designed to assure the continuance of these necessities.

When seen early, within twenty-four to forty-eight hours of onset, the area of redness is limited to one side of the nail, and commonly in the distal half of the nail-fold. The part is swollen and exquisitely painful, and close inspection will usually reveal a slight yellowish discoloration of the skin close to the free edge of the nail. This early is not a superficial discoloration, like the pointing of an intradermal pus collection, but a modification of the skin color by the pus beneath. At this stage a small lateral incision over the point of greatest tenderness allows the escape of a drop or two of pus, and recovery promptly follows. It may be necessary to give consideration to anesthesia, even though the incision cannot be large and is quickly accomplished by a sharp bistoury. Local use of ethyl chloride is usually sufficient to reduce the incisional pain, and does not produce devitalization of the tissue, though the discomfort after thawing may be con-

siderable. The discomfort incident to local anesthesia is moderate, but the postoperative anesthesia continues sufficiently long to carry the patient over the period of traumatic increase in pain and therefore is of value. If used, it should be injected into the lateral surface of the middle phalanges and not in proximity to the infected area. One per cent novocaine is sufficient concentration; addition of adrenalin is not necessary to prolong the anesthesia, and 2 c.c. injected on either side, with a five minute wait for diffusion, is usually sufficient. Such local anesthesia or a general anesthetic is necessary in the more radical treatment to be considered later.

The incision made, the dressing to be employed is to be given consideration. It must maintain freedom of drainage and attempts at use of drainage material in these small incisions is not only futile, but absolutely contraindicated. A continuous wet dressing of a mild antiseptic serves the necessary purpose. There is little to choose between boric acid, weak bichloride, 1:4000, hypochlorite solutions, or sodium citrate. The essential virtue of the wet dressing is maintenance of moisture. To this end a large, wet, gauze dressing is applied, of sufficient bulk to keep the part quiet and to provide a protection against bruising, and to hold a considerable amount of water.

To delay drying a covering of wax paper or cellophane is to be applied before the bandaging, and explicit directions must be given regarding the immersion of the whole dressing in the chosen antiseptic solution at regular intervals in order to maintain saturation—drying of the dressings, with adhesion of the blood and pus to the wound edges, absolutely defeats the purpose for which the incision was made. Recovery is usually far enough advanced that a light mild ointment, such as boric acid U.S.P., can be used at the end of forty-eight to seventy-two hours, and healing is complete in approximately a week.

When, however, the condition has been present longer, and infection is no longer



limited to the skin tissues but has found its way beneath the base of the nail and pus has been formed there, the treatment is not

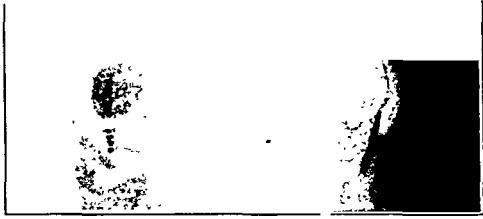


FIG. 2. Lines of incision used in paronychia. (Kanavel, Infections of the Hand. Phila., Lea and Febiger.)

so simple. Drainage must still be secured and maintained. The simple incision will not suffice; it is essential that the under-

the nail-edge is reached, a sharp pointed scissors inserted under the nail and all of the undermined portion removed. If removal is not complete, extension of the process continues; the area of the exposed nail-bed swells above the level of the part, like a fungating mass, further impeding drainage; the pain continues, making dressing a trying procedure, even though all the precautions before mentioned to maintain moisture are followed.

If there is any element of doubt concerning one's ability to remove the undermined nail completely the more radical and most effective lateral incision should be made. To avoid injury to, and prevent possible

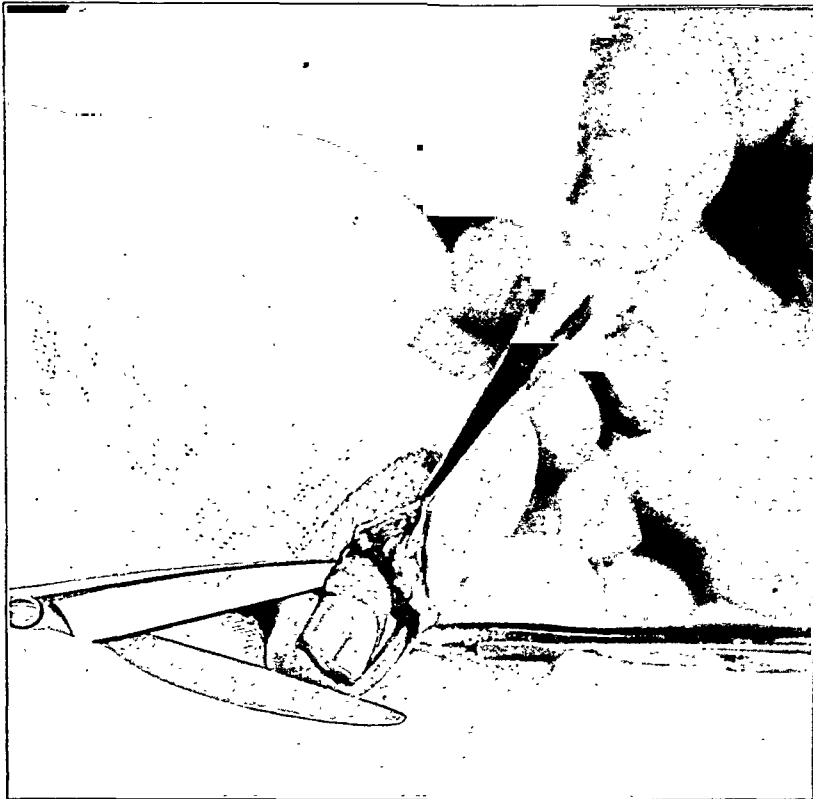


FIG. 3. Flap has been raised and the point of the scissors inserted under the base of the nail. (Kanavel, Infections of the Hand. Phila., Lea and Febiger.)

mined area of the nail be removed, else infection will continue to spread beneath that structure until it reaches the other side of the finger, with ultimate loss of a large portion, if not all, of the nail.

If the area involved is not yet extensive the eponychium may be pushed back until

subsequent permanent deformity of the nail bed, meticulous care must be made to place the incision lateral to, and not through the nail-bed. With the flaps elevated and turned back, the loosened part of the nail is removed, a rubber strip or vaselined gauze is placed between the skin

flap and nail-bed and the wet dressing applied as before. Where extension has reached the opposite nail border a bilateral incision is required (Fig. 2), the whole flap is raised (Fig. 3), and the proximal undermined nail removed, leaving the distal nail attached to the bed, where it serves the purpose of a natural, efficient protection during healing.

An annoying complication in these cases is the previously mentioned tendency to fungation-like elevation of the exposed base of the nail-bed. Control of this tendency is facilitated by reduction of bulk and substitution of dry dressings at the earliest favorable time. Kanavel has recommended that several hours exposure to direct sunlight be employed daily where possible.

Treatment of the previously mentioned chronic type of paronychia by the use of ointments and antiseptic solutions, has usually proved so disappointing that we have turned to the roentgenologist for his help. Through the courtesy of the X-ray Department of Temple University, I have received from Dr. Barton Young the following resume of their treatment of these very annoying conditions.

Roentgen treatment has been recognized as an aid in the treatment of infections but its real

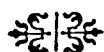
value is not universally appreciated. The application of x-rays to certain types of infection nearly always results in a subsidence of reaction which is at times prompt and spectacular. Our results with paronychia have been gratifying, but our cases have been limited, for the most part, to the chronic form, since we see paronychia only after other forms of treatment have failed.

Usually it takes only two or three treatments of from 75 to 100 r each to alleviate the symptoms, and produce resolution of the disease. The treatments are given every other day, or every third day, depending upon the course of the disease. We prefer unfiltered low voltage (90 — 100 K.W.P.) x-rays, using a target skin distance of 30 cm. There is no proof that reasonable variation of this technique will alter the beneficial results.

#### SUMMARY

The following may be listed as requisite in the treatment of the acute suppurative case of paronychia:

1. Early incision;
2. Complete removal of detached nail;
3. Avoidance of injury to nail-bed;
4. Maintenance of drainage by a voluminous dressing, kept moist until infection has subsided;
5. Light subsequent protective dressings until regrowth of nail.



# FELON (WHITLOW)\*

JAMES NORMAN COOMBS, M.D., F.A.C.S.

Assistant Professor of Surgery, Temple University; Associate Surgeon, Temple University Hospital

PHILADELPHIA

**F**ELON is a term applied to infections involving the finger, and most commonly affecting the distal phalanx on the palmar surface. The infection may be superficial,<sup>1</sup> known as a subcuticular and subcutaneous felon, or when deep is often called a subperiosteal bone felon. At times extension of infection by continuity or contiguity of tissue, especially in deep wounds or punctures, may lead to synovial thecal felon (suppurative tenosynovitis).

The mode of entrance of the infection may not always be clear. Forgotten injuries or abrasions as well as the dangerous punctured wounds are the common sources. Physicians and nurses frequently suffer from felons, due either to needle puncture while operating or in handling sharp pointed instruments. Constitutional debility and obese types may offer suitable soil for bacterial invasion.

The peculiar anatomy of the distal phalanx as pointed out by Kanavel, Koch and others, is a factor in the localized type of infection found in felon. The connective tissue framework produces a closed sac with septa containing columns of fat and glands which extend to the periosteum (Fig. 1). The blood supply is received from the two digital arteries which enter laterally and are enclosed in this fibroconnective tissue space. The epiphysis of the distal phalanx receives its blood supply from branches of the digital arteries before the blood vessels enter the closed space, the diaphysis receiving its blood supply from branches given off in the closed space (Fig. 2). The resulting pathological process can readily be seen. When infection enters the finger, the inflammatory exudate

limited by the closed space and by the dense palmar skin, obstructs the blood supply to this vulnerable area. Early abscess formation and necrosis of the diaphysis can be expected.

## SYMPTOMS

Pain is the most prominent symptom associated with redness and swelling. The pain in the beginning is usually sticking in nature, but soon changes to a severe pulsating type with marked tenderness. The finger tip by this time is bulbous and tense. If allowed to persist, lymphangitis may occur with signs of systemic intoxication, increased pulse rate and temperature. Proximal bone tenderness is not uncommon, often denoting periostitis or osteomyelitis.

## DIAGNOSIS

The diagnosis should be readily made by noting signs of inflammation confined to the terminal phalanx, especially with history of injury. In the differential diagnosis, lymphangitis and tendon sheath infection should be eliminated, particularly in the early case. With these infections, swelling is usually diffuse, often involving the entire finger, most of the swelling being on the dorsal surface of the finger with flexion deformity, particularly in suppurative tenosynovitis. Difficulty in the diagnosis may be experienced in the late case, when lymphangitis of tenosynovitis has occurred from extension of the finger tip infection.

## PROGNOSIS

Great care and judgment should be exercised in the management of hand infec-

<sup>1</sup> BABCOCK, W. W. Text Book of Surgery, Philadelphia, W. B. Saunders Co.

\* From the Department of Senior Surgery, Temple University, Philadelphia.

tions. As pointed out by Koch,<sup>2</sup> there should be at least one member of a hospital staff properly trained to treat minor surgi-

no matter how trivial, at the time of injury with a protective dressing.

With the onset of infection, absolute rest

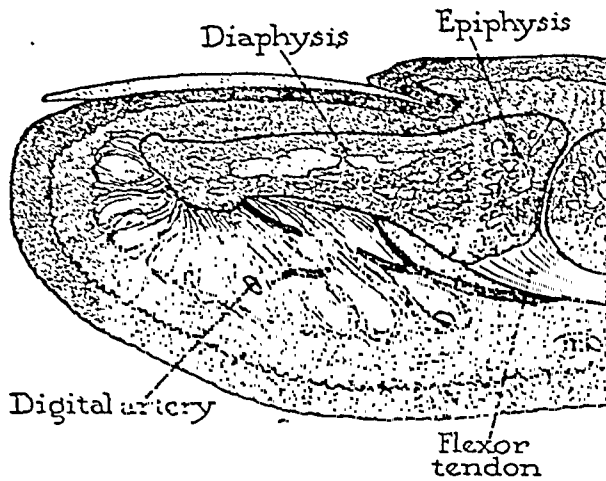


FIG. 1. Longitudinal section of terminal phalanx of finger, semidiagrammatic. Anterior closed space, in which felon develops, corresponds to the portion of the pad which overlies the diaphysis of bone. The epiphysis and termination of the flexor tendon lie outside this space. Small branches of the digital artery supplying the diaphysis pass through dense confines of the space and are quickly compressed by an inflammatory swelling. (Kanavel, A. B. and Mason, M. L. *Hand Infections*, *Cyclopedia of Medicine*, Vol. vi. Phila., F. A. Davis Co., 1932.)

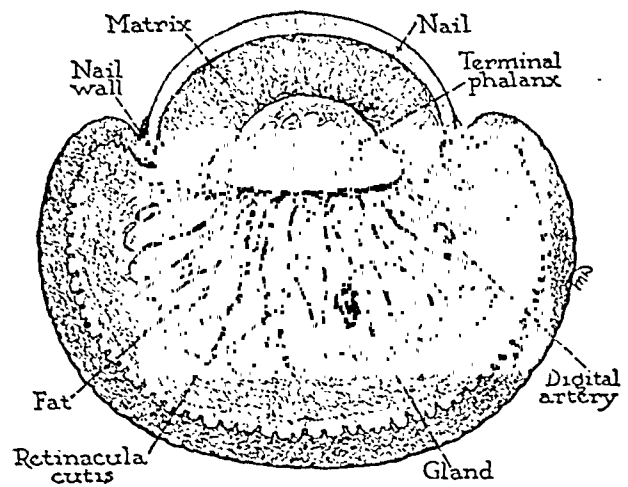


FIG. 2. Cross section of the terminal phalanx of the finger, semidiagrammatic. Dense fibrous columns (retinacula cutis) pass from the lower layer of the skin to attach to the periosteum. Between these columns is fatty tissue containing sweat glands, nerve fibers and blood vessels. To obtain adequate drainage of the felon, it is necessary to divide these fibrous columns. (Kanavel, A. B. and Mason, M. L. *Hand Infections*, *Cyclopedia of Medicine*, Vol. vi. Phila., F. A. Davis Co., 1932.)

cal conditions, especially infections of the hand, where good functional end results are so important. Koch properly states that such infections are usually treated by the most inexperienced members of the staff.

When treatment by free incision is carried out before bone necrosis ensues, early resolution is to be expected. However, when osteomyelitis and bone necrosis occur, one must expect a discharging sinus until sequestrum has been removed or discharged. The resulting deformity and dysfunction will depend upon the duration of suppuration and the amount of tissue destruction.

#### TREATMENT

The prophylactic treatment of felon should preclude the sterilization of wounds,

should be provided by the use of abundant moist dressings. A saturated solution of boracic acid, two parts, and alcohol 70 per cent, one part, is an excellent solution for such purpose. The dressings should include the entire hand and forearm. Provision should be made for introducing the solution at regular intervals for constant moisture with sufficient outside covering to maintain heat. Dressings should be removed daily for inspection. Careful observation to determine the proper time for incision is important. One should not wait for fluctuation. On the other hand, one should not incise until localization has occurred in the distal phalanx, and particularly one should not incise during the period of early lymphangitis. Incision during the early period of lymphangitis will be of no value and in many instances causes widespread dissemination of the infection along the lymph vessels of the hand, forearm, arm and at times blood stream invasion.

<sup>2</sup> Koch, S. L. Editorial. *Surg. Gynec. and Obst.*, 60: 879 (April) 1935.

Kanavel<sup>3</sup> points out that the incision should be made as soon as the edema restricted to the distal phalanx has pro-

phalanx with excessive edema limited to the phalanx, incision should be made.

*The Anesthetic.* The use of a general anesthetic<sup>4</sup> will allow the surgeon ample time to make an adequate incision to insure the best result. If local anesthesia is used, the digital nerves should be blocked at the base of the finger. The use of a local anesthetic or ethyl chloride in the zone of inflammation favors diffusion of the infection and inadequate incision.

*Method of Incision.* Naturally, the incision should be made over the area of greatest tenderness, particularly so if the case is seen early enough to decide that the closed space of the distal phalanx is partially involved. However, if it is realized that the entire distal phalanx is affected, the method of Koch may be used (Fig. 3). The incision should be placed to the side of the finger to preserve delicate tactile sensation, otherwise disturbed by a median incision. The knife is introduced on an oblique plane extending well to the opposite side of the finger, making a free incision with division of the columns of connective tissue and fat, thus liberating any associated discrete pockets of pus. In one's eagerness to make a free incision, the knife should not extend beyond the base of the phalanx; else, the

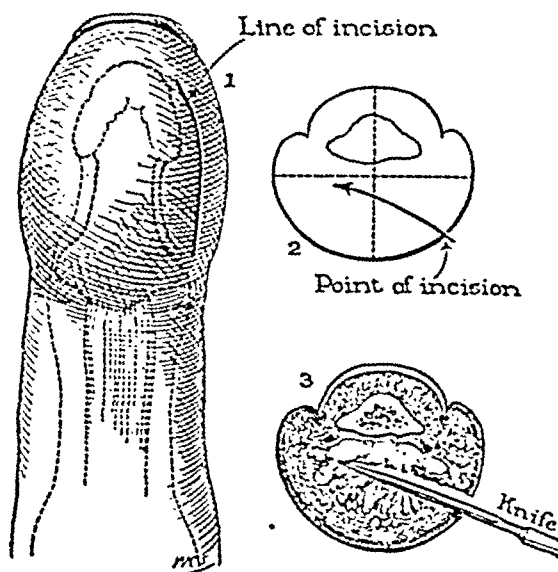


FIG. 3. Proper incision for drainage of felon. It is unnecessary and unwise to carry the incision across the tip of the finger. The essential feature of drainage is the transverse division of the retinacula of the skin. (From Koch, J. A. M. A., April 6, 1929.) (Kanavel, A. B. and Mason, M. L. *Hand Infections*, Cyclopedia of Medicine, Vol. vi. Phila., F. A. Davis Co., 1932.)

ceeded to a degree causing a hardness, but not necessarily the board-like feeling char-



FIG. 4. Deformity of terminal phalanx of thumb resulting from felon, improved by liberation of the scar and implantation of fat. (Kanavel, A. B. *Infections of the Hand*. Phila., Lea & Febiger.)

acteristic of pus in other subcutaneous areas. In general, one may say that when there is present a painful, tender, distal

flexor tendon sheath will be contaminated, favoring a tenosynovitis.

Vaseline gauze drains are suggested as rubber tubing may cause pressure necrosis.

<sup>4</sup> Koch, S. L. J. A. M. A., 92: 1171 (April 6) 1929.

<sup>3</sup> KANAVEL, A. B. *Infections of the Hand*. Ed. 6. Philadelphia, Lea and Febiger, 1932.

Excessive packing should be avoided; a thin strip of gauze introduced to the depth of the wound is ample. Early removal of the drain is suggested.

In the immediate postoperative treatment, abundant moist dressings should be applied to include the entire hand, as before described, during the period of localization, with rest in bed. For ambulant treatment, a splint extending from the finger tip to the elbow, with the use of a sling is to be considered for appropriate rest and immobilization to favor resolution.

*Results.* When incision has been delayed and mass destruction of soft tissue and bone has occurred, prolonged drainage is to be expected. In the case of necrosis of the diaphysis, drainage will continue until sequestrum has been discharged or removed. The removal of sequestrum may be facilitated by instrumentation, after partial separation has taken place. At no time should a curette be used on account of injury to or removal of periosteum, thus interfering with bone regeneration and

function. Amputation should not be considered unless there has been complete destruction of the terminal phalangeal joint.

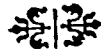
In the average uncomplicated felon, a good functional result is usually obtained. Plastic operations for correction of the deformity may be necessary (Fig. 4). Contracted scars of the finger tip may be liberated with implantation of fat, to improve function.

#### SUMMARY

The article deals, with the cause and varieties of felon, together with a description of the anatomy and pathology. The symptoms, diagnosis and differential diagnosis are discussed including the management and prognosis of finger tip infections.

The treatment includes methods aiding localization, types of incisions and drains to be used, also the care of osteomyelitis and bone necrosis.

Four illustrations are used to explain the text of the article.



# FROST-BITE: TREATMENT BY PASSIVE VASCULAR EXERCISE\*

## REPORT OF CASES

HUGH L. MURPHY, M.D.

BROOKLYN, N. Y.

**F**ROST-BITE is a definite pathological entity prevalent in winter months and characterized by varying degrees of reddening of the skin, and if not properly and early treated, to actual gangrene. In most standard textbooks frost-bite is a subject which is passed over lightly with only a few lines; the best treatment for it being prophylactic, or, if the sufferer has been exposed to the cold enough to deserve hospitalization, advice is offered to await demarcation of the gangrenous process and do a necessarily mutilating amputation of a part or whole of a foot or hand. Rubbing snow and ice on the frozen extremities and other crude methods in use for centuries are still the most common forms of treatment used today.

In the past few years there has been great interest aroused in peripheral circulatory conditions in general with remarkable results in saving limbs where amputations were conceded to be the only avenue open as a life-saving measure. Various workers<sup>1</sup> have repeatedly shown that many cases of definite organic arterial occlusion evidencing actual gangrenous lesions responded to the newer concepts of conservative therapy, thereby avoiding amputation and saving the entire limb, making an economic restoration of a useful citizen instead of a public charge.

With these recent advances in vascular therapy in cases of arteriosclerosis, thrombo-angiitis obliterans, etc., there are varying degrees of vasospasm superimposed upon an organic obliteration. One of the greatest factors in the prognosis is this element of vasospasm and the development of a collateral circulation to balance

tissue exchange in undernourished areas of ischemia.<sup>2</sup>

## PATHOLOGY

There may be considered three stages of frost-bite depending on their severity:

1. The stage of erythema in which the part exposed becomes red, with severe burning and a prickling sensation which is followed by vasoconstriction and numbness. Further exposure may be dangerous due to this anesthesia and more damage to the part may develop. If exposure ceases at this point there follows an intense reddening accompanied by itching, prickling sensations and swelling. Recovery may be complete or chilblains may develop which are characterized by bluish areas or nodules in the skin with a red areola.

2. The second stage presents large vesicles or bullae on a red skin containing clear watery fluid which may heal or become the site of a persistent secondary infection. This stage resembles severe second degree burns.

3. The third or terminal stage occurs from prolonged exposure to freezing and the circulation to the part is completely shut off. Gangrene of a varying degree results.

It is a debatable question as to whether the pathologic effects are a direct result of the cold causing a coagulation of the tissue with a thrombosis of the blood cells within the smaller terminal blood vessels, or due to the vasoconstriction, or to a trophic nerve disturbance. There may be a tendon or bone injury in severe cases.<sup>3-5</sup> Osteoporosis may ensue with necrosis of bone and

\* From the Vascular Disease Clinic of St. Mary's Hospital, Brooklyn, N. Y.

subsequent sinus formation. Joint spaces are narrowed or obliterated in late cases. Bone repair is slow. Epithelialization is

The only hope lies in the relaxation of the spasm of the arterioles with a reestablishment of an adequate circulatory balance.<sup>6</sup>



FIG. 1. Case 1. Second degree frost-bite of both hands twelve hours after exposure to zero weather. Note large blebs on fingers, swelling of forearm and wrist. Subcutaneous thrombosis.

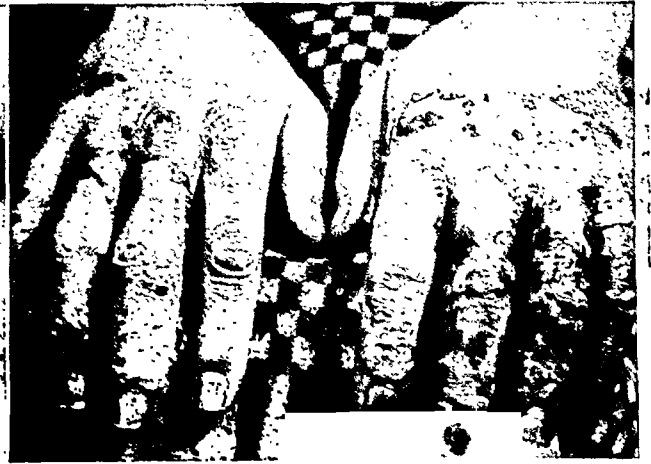


FIG. 2. Case 1. One week later; after ten hours of passive vascular exercise therapy. Note the several layers of new epithelium; thrombosis under nails, marked destruction of skin of fifth fingers of both hands.

extremely slow in cases that are allowed to heal spontaneously.

The clinical picture and what is known of the pathological picture together with the results to be presented point to an ischemia

#### PREDISPOSING FACTORS

Brahdy<sup>7</sup> emphasized many instructive points in a survey of 388 cases of frost-bite among New York City employees during



FIG. 3. Case 1. One month after starting passive vascular exercise therapy. Twenty-five hours given over this time. Note complete epithelialization with line of frost bite on hands. Some swelling and stiffness of the fingers remain.



FIG. 4. Case 1. After physiotherapy over a period of three months.

due to vasoconstriction as the basis of the condition. From a therapeutic standpoint this must be considered the one important factor. Undoubtedly, some of the damage is due to direct freezing and trophic changes.

the winter of 1933-1934. There were an unusual variety of cases which allowed a detailed analysis of the predisposing causes in this city. Thus he was enabled to reduce the incidence of frost-bite by giving timely warnings as to the proper clothes, habits, and ceasing outdoor work when the tem-



perature fell below 14°F. with a high wind blowing. The following are the factors emphasized as a result of this survey:



FIG. 5. Case 1. Return of normal function of flexion of hand and fingers shown.

1. The length of time of exposure after the first symptoms of numbness developed. Those workers who continued for several hours after this warning had the worst frost-bites.

2. Too rapid thawing was not advised nor was too prolonged rubbing with snow.<sup>8</sup> Body heat was less harmful, as by placing the hands in cotton or next to one's own body skin.

3. Age was not a factor except in cardiovascular disease or diabetes.

4. Clothing must not be too excessive to cause sweating and later chilling. Also shoes and gloves should not be constricting.

5. Alcohol is a factor only when taken too freely as to numb the consciousness. Many cases of severe frost-bite occur in drunkards on a bitter cold day.

6. Coffee and tobacco are known to lower the skin temperature by capillary constriction and are therefore not advised when one is exposing oneself to cold for several hours. Hot water and aspirin will cause a rise in skin temperature by vasodilation.<sup>9,10</sup>

7. Poor nutrition, as is found in relief workers, lowers their resisting power to exposure to severe cold.

8. Co-existing constitutional conditions of the exposed men, such as diabetes, myocarditis, arteriosclerosis, Buerger's and

Raynaud's disease, made them far more susceptible to the more severe form of frost-bite.

9. Weather condition: When the outdoor temperature is below 8°F. and between 8° and 14°F. with strong winds, work should be postponed. Rest periods indoors of one-half hour periods should be allowed every two or four hours under these conditions. Frost-bite rarely occurred when the temperature rose to above 24°F. regardless of how strong the wind may be.<sup>7</sup>

#### TREATMENT

The treatment of frost-bite is threefold, the prophylactic, the conservative (passive vascular exercise), and the surgical.

*Prophylactic.* This is the wisest course in the long run. By observance of the points mentioned, we could eliminate frost-bite, but the condition of the workmen being as they are and human nature being what it is, we will nevertheless have a great number in the large cities each winter. Those suffering from diabetes, arteriosclerosis, peripheral vascular diseases and general asthenia should not be exposed to the hazard of freezing.

*Passive Vascular Exercise Therapy.* This conservative method of treating frost-bite has been borrowed from the armamentarium of several groups throughout the country who are treating organic arterial disease of the extremities with a great deal of success.<sup>6</sup> This method is one of creating alternate negative and positive environmental pressure within a glass boot into which the affected extremity is placed. The immediate effect on cases of frost-bite treated is the relief of the severe pain associated with the thawing out, enabling the sufferer to sleep. Depending on the severity of the frozen extremity the treatment may last for one hour daily to ten or twelve hours, or until a change to normal color is observed. It is remarkable how soon pallor is replaced by a normal pink color of the skin even after ten minutes of passive treatment. In severer cases in the second stage the numbness disappears, the large

blebs rupture spontaneously and new epithelium appears on the exposed denuded areas. Infection is controlled more easily as

could be expected by waiting for spontaneous healing.

An added economic factor is the short



FIG. 6. Case III, A, chilblains due to frost-bite in a patient with infantile paralysis. Note hemorrhagic areas of local necrosis. B, front view.

the circulation is restored by a relaxation of the vasospasm due to the frost-bite.

Where there is tendon injury as manifested by stiffness of the joint, this treatment is continued until the skin of the affected limb is entirely healed. Later, diathermy and massage will restore the normal function to a surprising degree.

These patients have the best results when they are given the passive vascular exercise treatments early after exposure. After twenty-four hours actual gangrene has occurred to the terminal digits, and the best that can be hoped for in the more severe type is a quicker demarcation for surgery. Even in this stage the pain is greatly lessened in the restoration of the partly damaged tissue, with the added benefit of a lower level of amputation than

time of hospitalization required in patients treated by this method, usually one to two weeks being sufficient. They can become ambulatory very soon and return to the clinic for further treatment. As a contrast to this, how many of patients have we seen in the hospital for three or four months and still visit the surgical clinics for dressing as late as July and August?

Herrmann<sup>6</sup> has reported similar results in frost-bite cases treated by passive vascular exercise.

#### CASE REPORTS

CASE I. D. B., male, twenty-five years old, fell asleep in snow on January 22, 1936, after drinking to excess. His hands were under soft snow for one hour or more. The temperature was near zero. On arriving home both hands

were swollen, stiff and numb and a cold water bath was given to the hands, the feet, and the ears. He was admitted to the hospital twelve

hand, resulting in subsidence of the swelling and several layers of epithelium present in different areas; the fifth finger of each hand



FIG. 7. Case III. A, side view, after twenty-five hours of passive vascular exercise therapy over a period of one month; B, front view.

hours following exposure, with a severe second degree frost-bite of both hands (Fig. 1) and first degree frost bite of both feet and ears, the latter clearing up quickly in a few days. The hands presented a serious problem with anticipated amputation of both hands. There were large blebs on all fingers, thrombosis under the finger nails, and loss of sensation in four fingers, sensation was felt over the metacarpal area. Immediate passive vascular exercise treatment was given to both hands. After one hour the numbness in the fingers was replaced by a feeling and the pain disappeared. After the glass boots were removed from the upper extremities, some of the symptoms returned and more pavaex was given. Each day thereafter each extremity received one hour of treatment. By the end of one week, ten hours of passive vascular exercise were given to each

still looked dry and was discolored by old dried blood subcutaneously (Fig. 2). At this time there was normal sensation in all fingers, but a definite stiffness in the small joints of the fingers. The patient was discharged after two weeks of hospitalization. Thereafter he was treated in the Clinic.

In one month he had had twenty-five hours of passive vascular exercise therapy with the result shown in Figure 3. There was complete healing of the skin but some swelling and stiffness of the fingers persisted, due probably to tendon injury at the time of the frost-bite. Other physiotherapeutic measures were pursued for the next three months, such as diathermy, active and passive motion, with the end results seen in Figures 4 and 5. Here we see normal skin with no swelling, skin folds restored, new nails in evidence, and a very

useful hand as is shown by the restoration of the tendon injury to a normal function of full flexion of the fingers (Fig. 5).

CASE II. E. R., male, fifty-nine years of age, a P.W.A. snow shoveller, had the tips of the fourth and fifth fingers of the right hand frozen on January 24, 1936. He was treated for one month by the usual methods before he was sent to our clinic. There were still numbness and tingling of these two fingers; the fifth finger tip was reddened and slightly swollen, but the fourth finger was edematous in the distal two-thirds with a necrotic area 2 cm. by 1.5 cm. on the soft pad of this finger tip. A total of fifty hours of passive vascular exercise over a period of six weeks was given to this frozen member with the complete healing.

CASE III. D. M., female, aged twenty-one years, presents a case of chilblains. Eight years previously she had had infantile paralysis of both legs. She has always complained of coldness and blueness of the legs during the winter months. One month previously, on January 24, 1936, she was exposed to severe cold weather, after which she experienced painful tingling sensations in her legs, which became aggravated when near heat.

This patient noticed that numerous bluish blotchy areas appeared under the skin on both legs but more so on the left leg in the lower half. Pedal pulsations were felt easily. The skin temperature of the distal half of both legs was subnormal. The dark areas were very painful, irregular subcutaneous hemorrhages and also involved the tips of the toes of the left foot. Treatment consisted of twenty-five hours of passive vascular exercise over a period of one month with the end results shown in the accompanying photographs (Figs. 6A and B, and 7A and B). All areas of chilblains are healed with a pleasant sensation of warmth of her legs not experienced by this girl in years.

#### SUMMARY

Frost-bite is a prevailing pathological entity not uncommonly found among outdoor workers during the cold winter months, especially at temperatures below 8°F., or between 8° and 14°F. in the presence of strong winds.

The underlying pathology results in the disturbance in the blood supply to the part by a marked vasospasm producing ischemia and anesthesia and if this vasospasm is not

relieved within a period of twenty-four hours actual gangrene may result.

Prophylaxis is the most important factor in reducing the incidence of occurrence.

A comparatively new method of conservative therapy is offered in the alleviation of frost-bite, by the rapid relief of pain and the rapid restoration of circulation of the relaxation of vasospasm with a complete recovery in cases treated early. Late cases that have actual gangrene are relieved of pain and require less extensive surgery and a more useful limb therefore. Tendon injuries are not necessarily of a permanent nature. Epithelialization is rapid. Hospital stay is remarkably lessened as an added economic factor.

The passive vascular exercise therapy in frost-bite will enable the surgeon to change from the placid role of waiting for a time to amputate to an active role of trying to tide these sufferers through to a stage of actual healing by restoring their circulatory balance in a rapid and sound way.

#### REFERENCES

1. HERRMANN, L. G. and REID, M. R. The Pavaex (passive vascular exercise) treatment of obliterative arterial disease of the extremities. *Jour. Med.*, 14: 524-559, 1933.  
SHIPLEY, A. M. and YEAGER, G. H. Passive vascular exercise in the treatment of peripheral circulatory disease. *Surg. Gynec. and Obst.*, 59: 480-485, 1934.
2. DETAKATS, GEZA. The differentiation of organic and spastic vascular occlusions. *Am. Jour. Surg.*, 94: 321, 1931.  
LANDIS, E. M. Observations on peripheral vascular diseases. *Amer. Internat. Med.*, 8: 232, 1934.
3. VON RECKLINGHAUSEN. *Deutsch. Chir. Lief* 2 and 3.
4. DACOSTA. *Modern Surgery*. Ed. 9, Phila., W. B. Saunders, p. 110.
5. NAGELSAACHM. *Munchen. med. Wehnschr.*, 4: 353, 1919.
6. HERRMANN, L. G. *Passive Vascular Exercise*. Phila., J. B. Lippincott Co., 1936.
7. BRAHDY, L. Frost-bite among city employees of the City of New York. *J. A. M. A.*, 104: 529-532, 1935.
8. MACKLIN, A. H. Treatment of frost-bite. *Lancet*, 1: 884-885, 1925.
9. BIERMAN, W. Diagnosis and treatment of peripheral vascular diseases by physical agents. *New York Jour. Med.*, 36: 1405, 1935.
10. BARKER, N. W. Vasoconstrictor effects of tobacco smoking. *Proc. of Staff Meet. Mayo Clinic*, 8: 284, 1933.
11. KAPLAN, THEO. Frost-bite. *Am. Jour. Surg.*, 32: 318 (May) 1936.

# HAND INFECTIONS: OFFICE TREATMENT

ALFRED H. IASON, M.D., F.A.C.S.

Attending Surgeon, Jewish Hospital of Brooklyn and Beth-El Hospital, Brooklyn; Assistant Clinical Professor of Surgery, Long Island College of Medicine

BROOKLYN, N. Y.

**I**NFECTIONS of the hand differ from infections in other parts of the body mainly because of the complicated anatomical structure of the extremity.

Generally there is too little stress paid to the macroscopic and microscopic anatomy of the various structures which compose the hand, and it was not until Kanavel's admirably thorough work was published that attention was directed to a more scientific view and a more efficient basis for their treatment. A realization of the technical possibilities, and an appreciation of the economic loss suffered by patients due to improper and inefficient surgical methods, have raised the standards which obtain today in the surgical treatment of hand infections.

Questions are frequently propounded as regards the proper limitations of minor surgery of the hand, or rather as to hand infections which may be treated correctly in the physician's office as distinctly minor surgical cases. The following, in our view, are the types which may be properly treated as ambulatory:

1. Infections around the nail, such as eponychia, paronychia and subungual abscess. In this class may also be included subungual hematmata, which are prone to infection.

2. Felons or terminal closed-space infections.

3. Collar-button or collar-stud abscesses, or lumbrical space infections.

4. Furuncles and carbuncles.

5. Cellulitis, with subcutaneous abscess formation.

Tenosynovitis, midpalmar space infections, thenar and hypothenar abscesses and subflexor space or Parona space infections, should be treated in the hospital because

of their general severity, the danger of complications and postoperative deformities resulting in severe economic loss to the patient. It is an evidence of poor surgical, or other judgment, to attempt office treatment of these infections under general or local anesthesia. A complete operative room set-up for these patients is just as imperative as it is for an appendicectomy. An inexperienced or mediocre surgeon may at times successfully remove an easily accessible, acutely inflamed appendix; he is not justified however in operating on the hand unless he has a thorough knowledge of the surgical anatomy with its complexity of tendons, fascial planes, blood vessels and nerves.

Auchincloss wrote, "The story of hand infections centers about anatomical architecture. With no desire to minimize the importance of bacteriological, serological and chemical aspects, one must remember that it is their bearing on structures having an anatomical arrangement peculiarly their own that concerns us, rather than these subjects as general entities."

1. *Infections Around the Nail.* The nail, a modified skin structure, derives from the layer which is known as stratum lucidum; near its base is a whitish portion, denominated lunula. The entire nail rests upon a bed. The subjacent epithelium is the nail matrix. The subungual space, the area between the nail and the bed epithelium, is extremely vascular. A somewhat wedge-shaped structure of skin, the eponychium, lies dorsal to the nail-root. Between the eponychium and the dorsal skin is a layer of subcutaneous tissue rich in lymphatics but poor in fat. On both sides one finds the paronychia which is continuous with the eponychium and of a similar structure. The

skin in this region is noticeably more flexible and softer in consistency than on the palmar or volar aspect of the finger

inflicted by a manicurist. A simple paronychia (Fig. 1c) may respond to the treatment recommended for eponychia, or one

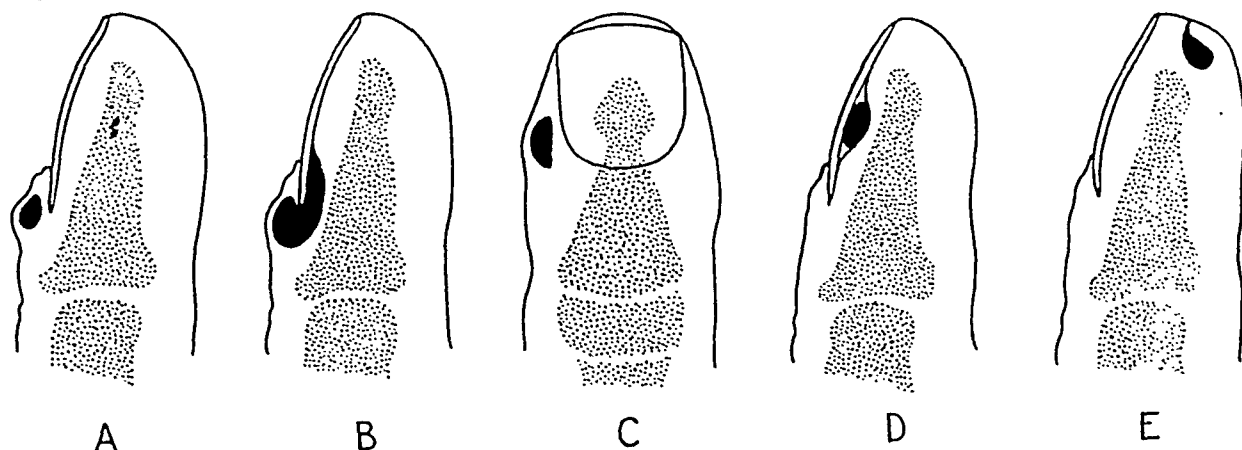


FIG. 1. Infections around the nail.

because of the greater flexibility and elasticity required of the entire dorsal skin surface of the finger to permit of flexion (Fig. 1).

Infections of the subcutaneous tissue, between the dorsal epidermis and the reflected epithelium of the eponychium, may result in cellulitis or it may localize and form a small abscess which appears like a pus blister. This type of infection is very mild and may be cured by gently pushing back the roof of the blister or pricking it with a sharp needle and allowing the pus to escape (Fig. 1A). The redundant, overlying epidermis is then clipped away to permit proper drainage. The insertion of a drain is unnecessary and wet dressings applied for a few days usually effect a cure. This condition is frequently confused with the more serious infection of the nail-bed which results in subungual abscess. Even though pus is not observable here under the nail, its presence is presumed on the basis of a simple eponychia which fails to yield to the mild form of treatment described (Fig. 1B). One may be suspicious of a subungual abscess if there is discoloration in the region of the lunula and a yellowish-white color due to the actual presence of pus beneath the nail.

In paronychia similar conditions are noted. This common infection frequently results from neglected hangnails or trauma to the cuticle over the base of the nail

may find that the pus has burrowed underneath the nail forming a subungual abscess.

When the diagnosis of this type of abscess is made, with or without eponychia or paronychia, simple incision into the soft tissue will not always effect a cure. Pain is often unrelieved for several days after surgical intervention, and it will persist until the roof of the abscess, which is the superimposed nail, is removed (Figs. 1B and 1D).

It is inadvisable and unnecessary to remove the entire nail; it is generally sufficient to remove the base up to the distal margin of the lunula, care being exercised that a complete segment is removed and that no fragments of the nail are left at the juncture of the eponychium and paronychia which may act as plugs preventing adequate drainage. On removing the nail, one may not note a gush of pus, but it will be observed that there is, nevertheless, constant drainage of purulent material, and that relief usually follows within six or eight hours.

When a subungual abscess is associated with paronychia, some surgeons advise removal of the nail with its contiguous nail-bed on the side of the infection, thus preserving the remainder of the nail-bed and the nail. This is seldom necessary because the infections generally are located near the base of the nail and are cured only

on removal of the entire nail-base. The portion of the nail distal to the lunula, which is known as the body of the nail, is

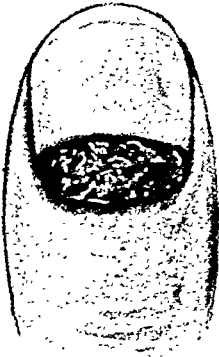


FIG. 2. Subungual abscess associated with paronychia. (After operation.)

not removed. The exposure of a large, tender, vascular surface is thus avoided. When this is preserved, within a week after operation, the exposed portion of the nail-bed becomes dry and the remaining distal portion acts as a covering for the tender subungual tissue, and the patient is able to resume his vocation. The new nail will gradually displace the distal portion of the old nail without incapacitating the patient (Fig. 2).

2. *Felons or Terminal, Distal Closed Space Infections.* These are infections of the palmar or anterior aspect of the finger at the distal phalanx. The reader will note in the accompanying illustrations that the terminal closed space is made up of what Auchincloss calls "fat caverns" which run anteroposteriorly from the chorium to the periosteum, and the terminal closed space extends from the tip of the finger to a point about  $\frac{1}{4}$  inch distal to the crease and is completely separated or walled off by an envelope of fascial tissue not only from the flexor profundus tendon, but likewise from the epiphyseal end of the bone. Certain surgeons believe that there is a continuity of the so-called deep connective tissue trabecula with the periosteum of the bone, and that lymphatics are to be found between the skin and the bone. According to

Kanavel, deep penetration of the sweat glands into the subcutaneous tissues is an important factor in hastening bone involve-

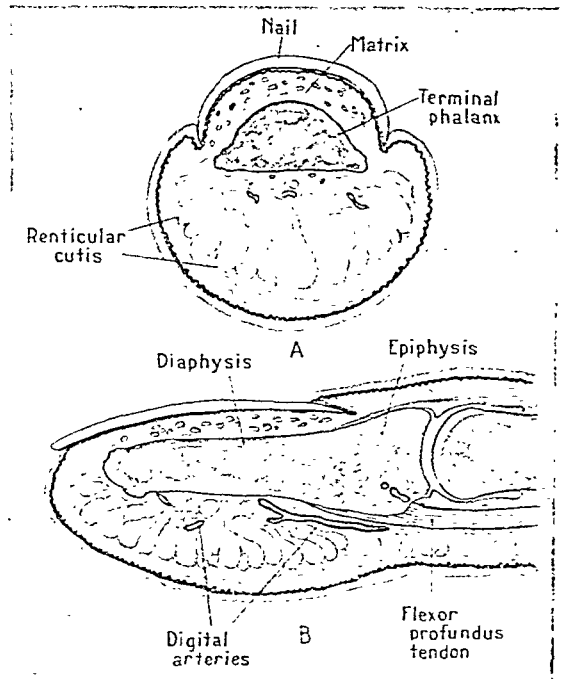


FIG. 3. Cross and longitudinal section of terminal closed space.

ment. In addition to sweat glands, these columns of fat contain nerve filaments and blood vessels (Fig. 3).

It is noticeable on careful dissection that the artery to the epiphyseal end of the bone is independent of the vessels that supply the more distal portion or shaft. The diaphysis of the phalanx is supplied by digital vessels and end filaments of the digital nerves. The epiphysis, however, receives its blood supply through small branches of the digital artery before they enter the closed space. These anatomical facts are important considerations in determining not only the course and rapidity of infection, but in the scheme of treatment.

*Etiology.* The etiological factor is usually a needle or pin prick or perhaps some unnoticed injury. The wound becomes sealed due to the toughness of the skin and the infection spreads immediately along the line of least resistance, which is towards the bone.

**Symptoms.** Pain, at first mild in character, becomes severe and throbbing within twenty-four hours as the tissue spaces fill with inflammatory exudate; in a few days the volar aspect of the terminal phalanx appears swollen and bulbous. The patient develops a temperature. If untreated, in about four days, the finger becomes fluctuant and exquisitely tender.

**Diagnosis.** The localization of the painful swelling and the shape of the distal phalanx, without extension of tenderness along the flexor tendon, are pathognomonic of terminal closed space infection. One rarely notes lymphangitic streaks extending up the forearm.

**Treatment.** The fascial spaces or fat caverns in the pulp of the finger run antero-posteriorly, and in order to empty these (Fig. 3), one must incise transversely so that the pus will drain readily from both ends of the divided channel. It is readily understood therefore why the fish-mouth or horseshoe incision (Fig. 4) should be the method of choice; and likewise, one may readily appreciate the futility of a longitudinal incision over the middle of the terminal closed space. The latter type of incision does not completely empty the purulent exudate, nor does it permit adequate drainage and it deforms the distal phalanx, disturbing, too, the tactile sense. On the other hand, the horseshoe or fish-mouth incision provides adequate drainage, heals with no deformity, and does not affect the tactile sense. Once the diagnosis is made, surgical intervention should be immediately instituted; and it may be carried out at the base of the finger under local block or infiltrative anesthesia.

An incision is made in the manner described and a piece of dry gauze is inserted between the two flaps for hemostasis. A wet dressing is not applied until about eight hours after operation. If used prior to this time, bleeding may be promoted by the hygroscopic action of the moist dressing. The wound need not be dressed for two days; thereafter daily dressings are in order. The packing is

removed on the fourth or fifth day after thoroughly moistening the finger in order to loosen the gauze, thus permitting pain-

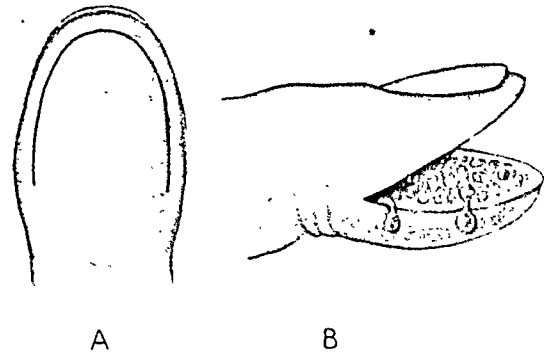


FIG. 4. Fish-mouth or horseshoe incision.

less removal. The purulent discharge practically ceases about the seventh or eighth day and balsam of Peru dressings are applied to the wound. Healing then takes place rapidly and at the end of a few weeks further dressings are unnecessary.

If the incision is properly made there is no danger of injury to the flexor tendon with resultant suppurative tenosynovitis. This complication may be avoided if the ends of the horseshoe are not carried nearer to the distal crease than one-quarter inch.

**Complications.** Osteomyelitis of the terminal phalanx, as a complication, occurs rarely. Absorption of calcium takes place in the terminal phalanx, on account of chronic passive congestion, and the x-ray plate gives the picture of an osteoporosis which is frequently mistaken for osteomyelitis. Almost the entire bone distal to the epiphysis apparently disappears, but one will note, after a period of three to nine months, that repeated x-ray examinations reveal a reappearance of the normal density of the terminal phalanx due to the impregnation of the fibrous matrix with calcium after the establishment of the normal bone and soft tissue circulation (Figs. 5A-I). In osteoporosis one does not note the stripping or elevation of the periosteum which occurs in osteomyelitis. In the latter case, the wound does not heal until the loose particles of bone are extruded or removed, and the osteoporotic appearance is more patchy



in type than in the physiological osteoporosis described (Figs. 6A and B).

Various etiologic factors are concerned

3. *Collar-button or Collar-stud Abscesses (Subepithelial Abscess)*. This type of infection is encountered in working men who

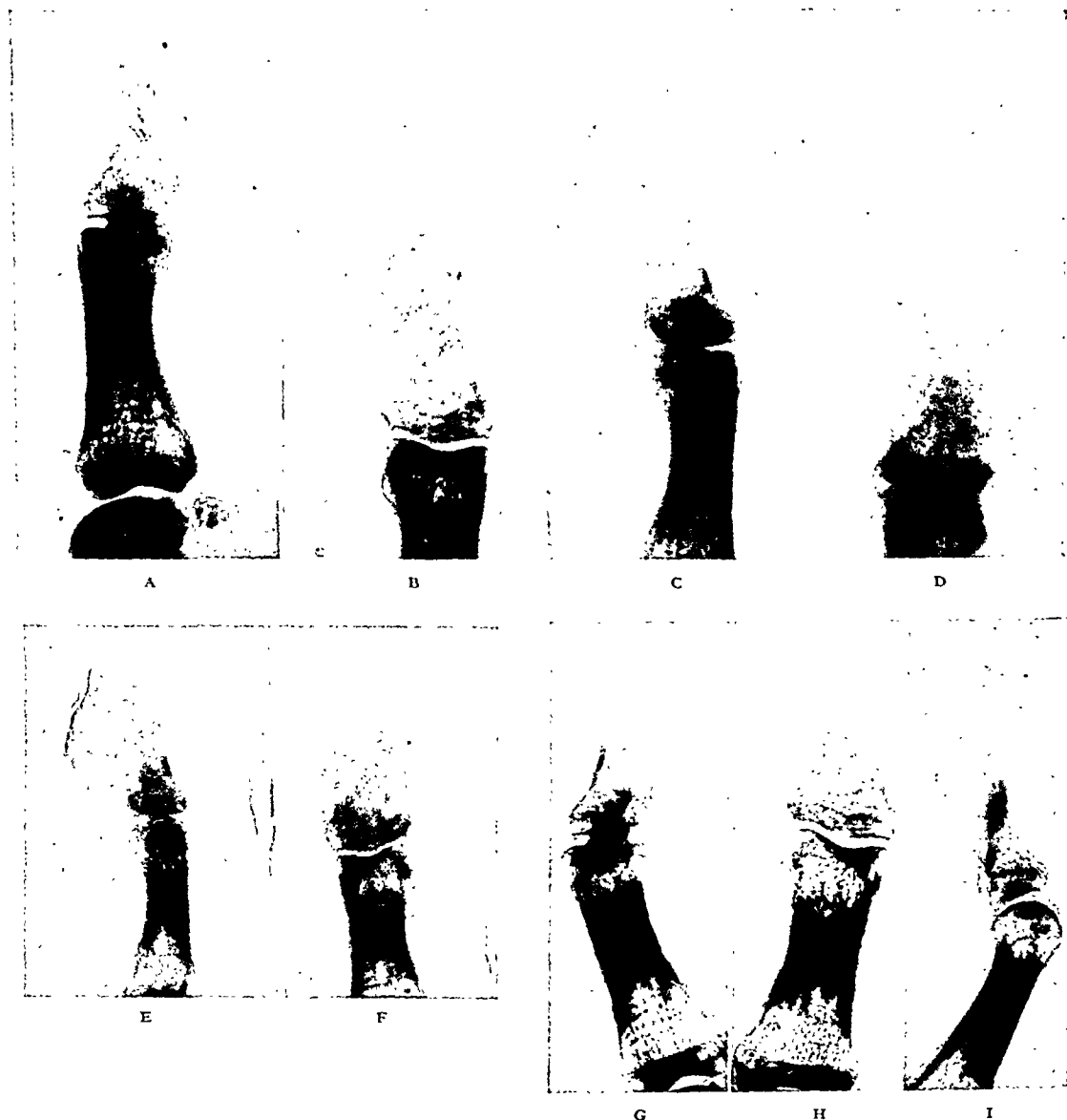


FIG. 5. A and B, July 13; A, lateral view; B, anteroposterior view; C and D, July 20; C, lateral view; D, anteroposterior view; E and F, July 27; E, lateral view; F, anteroposterior view; G and H, August 10; G, lateral view; H, anteroposterior view; I, lateral view, September 8.

in the bone involvement of terminal closed-space infections. They are:

1. The contiguity of the deep connective tissue trabecula with periosteum;
2. The perpendicular course of the lymphatics, from the skin to the bone;
3. The deep penetration of sweat glands into subcutaneous tissue.

have a thick palmar epidermis. It originates as a superficial infection beneath the epidermis which, in time, ruptures and burrows down through the dermis into the subcutaneous tissues. This infection may remain at times localized and rupture subsequently through the skin; when this is not possible, owing to integumental thick-

ness, it may spread down through the skin fibers of the palmar aponeurosis forming a collection of pus between the lumbrical

*Treatment.* Under local block anesthesia, infiltrating in a direction proximal to the infection in the palm, an incision is

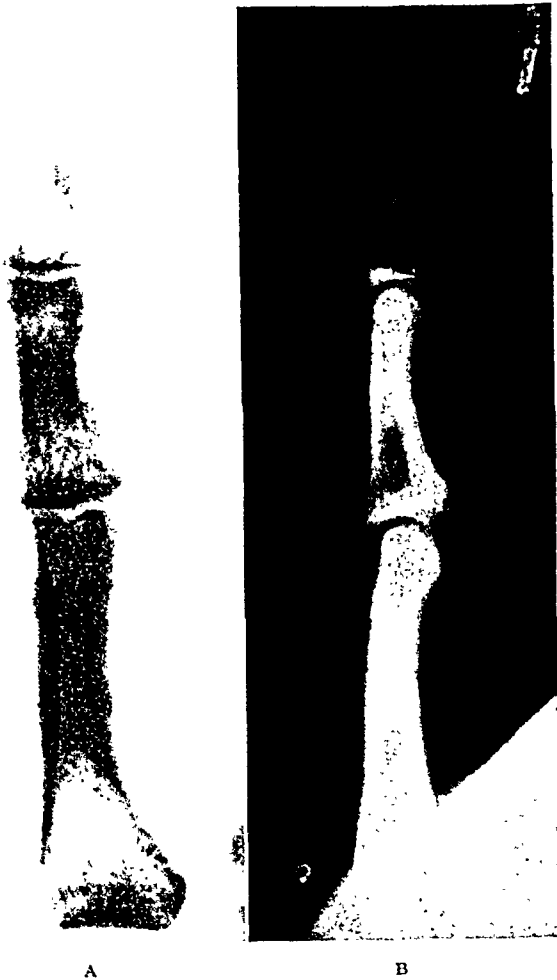


FIG. 6. Osteoporosis of a terminal phalanx, with a closed space infection, showing a restitution to normal after many months. The bone picture may be interpreted erroneously as osteomyelitis.

muscles pointing towards the web (Fig. 7). This peculiar type of infection eventuates in what is termed the "collar-button" or "collar-stud abscess" and receives this appellation because it is characterized by a superficial accumulation of pus in the palm connected by means of a narrow channel with a similar, and often larger collection in the deeper tissues. Oftentimes it will be noted that these collections of pus tend to burrow into the superficial tissues along the volar aspect of the proximal phalanges. A tremendous amount of edema is noted on the dorsum of the hand, but careful examination will reveal the absence of tenderness along the flexor tendon.

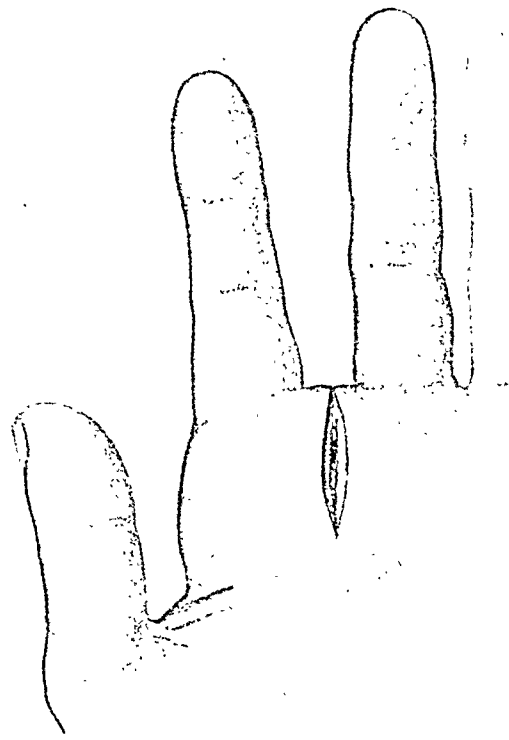


FIG. 7. Collar-button or collar-stud abscess (subepithelial abscess), showing line of incision.

made through the web, extending into the palmar aspect of the hand through the true skin (Fig. 7). An artery clamp is then inserted into the lumbrical space, spreading the surrounding tissues, thereby releasing a large amount of pus which is out of all proportion to the preconceived size of the abscess from a mere view of the superficial inflammatory area. There is moderate bleeding occasionally from the digital vessels, but this is readily controlled by packing with a strip of dry gauze. The wound is then dressed; wet dressings are not applied until twenty-four hours later owing to the possibility of exciting bleeding by the hygroscopic action of the dressings. The gauze is removed in two or three days. Wet dressings are continued for a few days longer, and then a mixture of balsam of Peru and castor oil is applied to the wound to stimulate the growth of granulation tissue. Healing is complete in about two weeks (Fig. 7).

4. *Furuncles and Carbuncles.* Furuncles and carbuncles usually occur on the dorsum of the hand or on the fingers, and do not

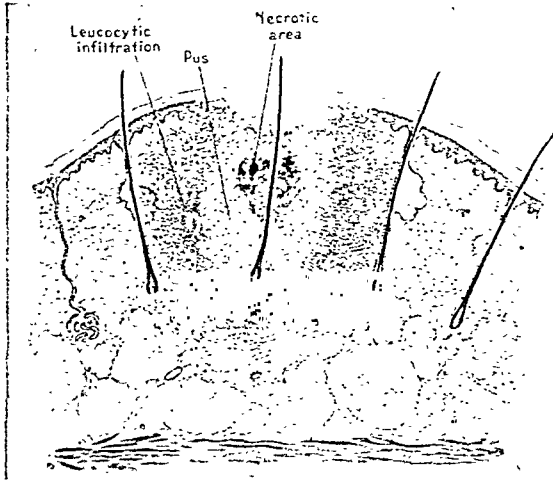


FIG. 8. Diagram showing carbuncle; a, pus; b, necrotic area; c, leucocytic infiltration.

differ in any respect, clinically or pathologically, from similar infections in other parts of the body. Frequently, however, they do not receive the radical treatment indicated and a long period of convalescence is the result. Infectious material finds entry by way of the hair follicle and its contiguous sebaceous gland, or directly through the sweat gland, thereby causing an infection in a column of fat which spreads to the deeper layers of the subcutaneous tissue and then laterally to the adjoining fat columns, through which path it reaches the skin. A considerable area of the subcuticular tissues, in this manner, becomes honey-combed with abscesses. One may observe the initial focus coming to the surface, giving the impression of a furuncular infection. A simple differential point in the determination whether one is dealing with a carbuncle or a furuncle is that around the central necrotic zone a secondary one of infection appears, with small, sieve-like openings in the skin which give the appearance of numerous furuncles discharging small quantities of pus, and away from the immediate area, one of brawny induration is noticeable, the roof of the central necrotic area. This is bounded by a leucocytic zone of infiltration (Fig. 8).

When dealing with a simple furuncle it generally suffices to avulse the hair with its follicle to provide adequate drainage. Furuncles should never be squeezed because the pus from a single furuncle may readily be forced into neighboring columns of fat, thereby converting a minor infection to a more serious one, the carbuncle.

*Treatment.* For the simple furuncle, then, avulsion of the hair usually suffices. If wet dressings are applied, the infection usually resolves in three to five days, without avulsion of the hair and its root. The pain and discomfort are, of course, out of all proportion to the actual size of the infection.

Carbuncles require adequate drainage by crucial incisions beyond the tertiary zone of inflammation, undermining of the resultant four flaps and the removal of necrotic masses. Care must be observed to keep the incision and the dissection superficial to the underlying tendon sheath, for between it and the nethermost area of the carbuncle there is a leucocytic zone of infiltration which acts as a defensive barrier. The careless use of a scalpel without proper visualization may injure the tendon sheath and cause a fulminating infection. After the excision of the central necrotic mass, the gaping wound is packed with gauze which is removed in about three days. There is usually little or no bleeding. Ligation of blood vessels is generally unnecessary. Troublesome bleeding is checked by firm gauze packing sewn over the skin flaps with single sutures and made to serve as a hemostatic tampon. Repacking of the wound after the three-day interval is unnecessary because drainage usually continues and sloughing areas are easily removed with forceps or scissors. It is poor surgery to excise a carbuncle in its entirety because a large raw area necessarily results requiring skin grafting.

5. *Cellulitis with Subcutaneous Abscess Formation.* This condition usually complicates a superficial infection such as a furuncle, for example. The infection, instead of partial localization in the skin, as in carbuncles, spreads diffusely into the

subcutaneous tissues and forms a localized abscess. This does not, as a rule, involve the tendon sheaths or tendons primarily.

more correct evaluation of the gravity, and consequently, of the probable course of a given case.

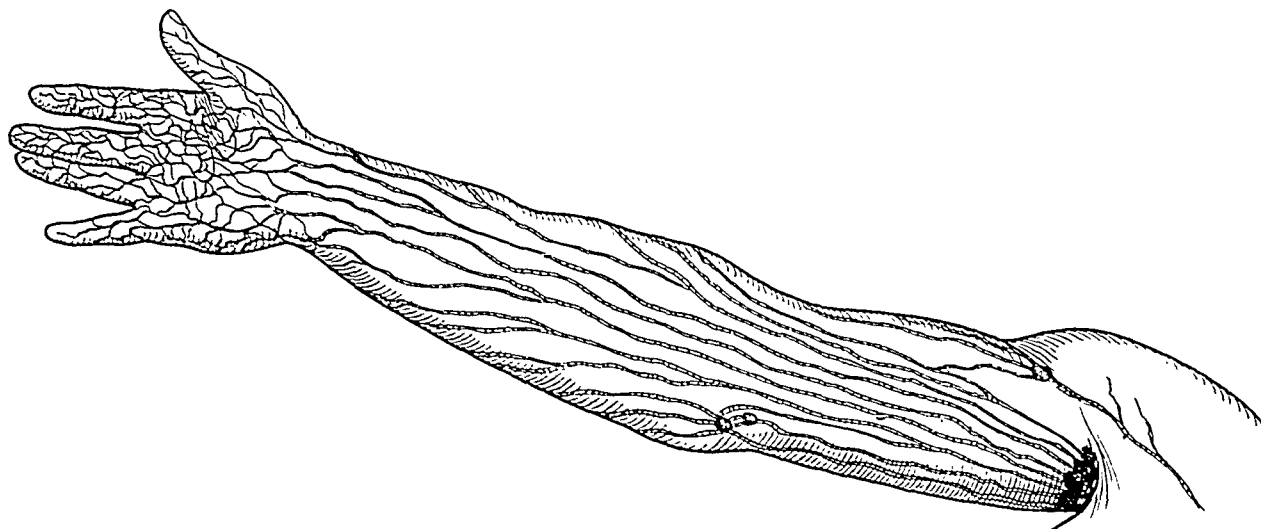


FIG. 9. Lymphatic drainage system of upper extremity.

But improper surgical treatment with the careless use of the scalpel may introduce the infection into the deeper tissues.

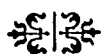
The *treatment* consists in the thorough evacuation of the abscess by careful incision through the skin and gentle separation of the deeper tissues with an artery clamp. This may be done under local block anesthesia. If the abscess is extensive, the patient should be hospitalized. This condition should not be confused with a cellulitis which occurs secondary to a perforating tenosynovitis or a thenar, hypothenar or midpalmar space abscess. These infections should be classed as major surgical ones.

#### CONCLUSIONS

A thorough knowledge of the surgical anatomy of the hand is an absolute imperative in the treatment of its various injuries and infections. Such knowledge assures a

The hand is the most anatomically complex mechanical bodily member and as such demands profound attention, ameliorative or curative, for functional, economic and esthetic reasons.

We have adverted to infections around the nails and the determination of their extent, gravity, and proper treatment; to felons or terminal closed space infections with, at times, difficult elicitation of fluctuation and the necessity of early incision properly placed; to collar-button or collar-stud abscesses in which, because of the loose character of the areolar tissue in and about the lumbrical muscles, infections spread rapidly to adjacent mechanically vital structures; to furuncles and carbuncles; to cellulitis and to subcutaneous abscess formations in which a correct diagnosis and use of the scalpel are essentials.



# REMOVAL OF FISH HOOK EMBEDDED IN FINGER

CHARLES C. MURPHY, M.D., F.A.C.S.

Chief Surgeon, Southside Hospital

AMITYVILLE, N. Y.

THIS injury is sufficiently prevalent to be worthy of consideration. The most important points in the treatment of this condition are prophylactic care and avoidance of unnecessary trauma to the tissues in its removal.

A large proportion of the infections of the hand follow trivial injuries such as those caused by the fish hook. Most of these infections could be prevented by efficient first aid, which includes forcing blood out of the wound, prompt application of tincture of iodine, merthiolate, or other such effective antiseptics, removal of the foreign body aseptically and immobilization when in doubt.

With increasing experience we have come to lay greater stress on careful thorough cleansing of the wound with soap and water, and abstinence from the use of powerful and irritating antiseptics, because of the destructive action of such antiseptics on exposed and non-resistant tissue cells.

If grease and dirt cannot be removed by soap and water; ether, benzene or some other fat solvent may be used, followed again by soap and water, after which, tincture of merthiolate is applied to the injured digit.

The area involved is infiltrated with local anesthetic, my preference being butyn-

epinephrine solution  $\frac{1}{4}$  per cent, the advantage being immediate and prolonged anesthesia as well as a minimum of toxicity. If the fish hook is firmly and deeply embedded in the underlying tissues, the best procedure in my hands has been to puncture the skin at the point of the fish hook if palpable, either with the point of the hook itself or by a small stab incision with the scalpel allowing the point of the hook to emerge sufficiently to cut the hook on the shaft proximal to the barbs using a wire cutter or bone cutting forceps for this purpose. The hook then being withdrawn through the point of entrance, a 50 per cent alcohol and boric dressing is applied and kept moist while there is any evidence of tenderness or pain. Incision should be made laterally when practicable, to avoid injury to the tendons and tendon sheaths to avoid possible tenosynovitis and away from the joint space to avoid trauma and possible infection into the joint itself. Where infection with tetanus bacilli is possible this should be anticipated by the administration of tetanus antitoxin at the time of the surgical procedure. The possibility of infection with the organism of gas gangrene must likewise be kept in mind and the wound examined daily for such infection, when feared.



# POLYDACTYLISM

HORACE E. TURNER, M.D.

Attending Orthopedic Surgeon, The American Hospital of Chicago

CHICAGO, ILL.

**P**OLYDACTYLISM is the occurrence of more than the usual number of fingers or toes in any animal, such as poultry, in cattle, and in sheep, as well as in humans.<sup>1-8</sup> It is frequently associated with syndactylism, which is the occurrence of a web-like growth between the fingers or toes.

Supernumerary fingers and toes have been observed and numerous articles written about them but up to date no definite etiology has been found. The condition seems to be best explained upon a hereditary basis in which the dominant Mendelian characteristic is that of polydactylism.<sup>2,5,10,12</sup> In 1866, Lawrence and Moon described a group of patients all suffering from similar symptoms, and since then such symptoms constitute what is known as a Lawrence-Moon-Biedl syndrome. In 1922 Biedl called attention to the presence of polydactylism in many of these cases. In 1929 Harvey G. Beck reviewed 35 reported cases of the Lawrence-Moon-Biedl syndrome, but offered no further information on the polydactylia phase. In a series of 64 descendants of an original effected parent, 27 were affected, 33 unaffected, and 4 doubtful.<sup>11</sup>

This condition is found among the peoples of practically every country and is no more prevalent in males than in females. It affects the fingers more frequently than the toes. The supernumerary digits are usually marginal, undeveloped, and lacking in a corresponding metacarpal bone.

The cosmetic effect usually brings the patient to the doctor, but occasionally the impediment that the supernumerary digit causes while the patient is at work or the difficulty of getting shoes to fit when the affliction occurs on the foot, is what causes a physician to be consulted.

Many varieties exist, ranging from the simple one phalanx, off-shoot type, to the

complicated osseously combined type complicated further by syndactylism and supernumerary metacarpal or metatarsal, as the case may be.<sup>12</sup>

The diagnosis is obvious, but before satisfactory treatment may be given, the physician must make a careful roentgenological study of the extremity in order to be sure which digit is supernumerary as well as to discover any accompanying complication. Treatment consists of the surgical disarticulation of the extra digit in such a way as to leave the least offensive scar from the cosmetic as well as the utilitarian viewpoint.

## SUMMARY

Polydactylism is a hereditary condition.  
The diagnosis is obvious.  
The treatment is surgical.

## REFERENCES

1. VATTI, G. Polydactylia—cases in domestic animals. *Boll. d. Soc. eustaciana*, 26: 1-20 (March) 1928.
2. GRENE, L. Polydactylia in horses and pigs. *Deutsche Tierarztl. Wchnschr.*, 36: 348 (May 19) 1928.
3. WILSON, H. M. Clydesdale foal's supernumerary digits. *Vet. Rec.*, 7: 577 (July 2) 1927.
4. BOAS, J. Z. V. Polydactylia in horse. *Zool. Jabrb. Abt. f. Anat.*, 51: 313-322 (Nov. 6) 1929.
5. KOEHLER, O. Heredity of supernumerary fingers. *Biol. Zentralb.*, 49: 705-717, 1929.
6. SEIFERLE, E. Atavism and polydactyly of hind paws of dog. *Morphol. Jabrb.*, 57: 313-380 (Jan. 25) 1927.
7. DRAHM, F. Polydactylia in horses. *Berl. tierarztl. Wchnschr.*, 43: 94 (Feb. 11) 1927.
8. PANNET, R. C., and PEASE, M. S. Polydactylia genetic studies in poultry.
9. NYLANDER, E. D. Pre-axial polydactylism in five generations of Swedish family. *Upsala lakaref forb*, 36: 275-292 (May 22) 1931.
10. McCLINTIC, B. S. Five generations of polydactylism. *Normal heredity*, 26: 141-144 (April) 1935.
11. MANSON, F. S. Hereditary syndactylism and polydactylism descriptive of recent additions to pedigree. *Brit. Med. Jour.*, 2: 1044 (Dec. 8) 1934.
12. SCHATZKI, P. Concealed syndactylic polydactylia and triangle formations in human metacarpus. *Arch. Orthop.* (Jan.-March) 1936.

# TREATMENT OF VARICOSE VEINS AND ULCERS\*

ROBERT F. BARBER, M.D., F.A.C.S.

Professor of Clinical Surgery, Long Island College of Medicine, Director of Surgery, Kings County Hospital

BROOKLYN, N. Y.

THE author's impressions are based on an extensive experience with the treatment of varix and ulcer cases, which has come largely from the Varicose Vein Clinic of the Long Island College Hospital and a considerable number of private patients, totaling over 25,000 individual treatments.

Patients as well as doctors repeatedly ask the question "What is the cause of varicose veins?" It can be answered in all frankness that we do not know. To put an end to further questioning, we have always added to this statement that the dilatation is due to a condition of the wall of the vein in which a congenital or an acquired weakness has permitted the intravenous pressure to distend the vessel gradually.

In the treatment of varices of the legs we record the state of the dilatation in degrees, for practical purposes using "moderate" and "severe," with a description of the distribution of the lesion. This point is raised because it is much more satisfactory to treat the moderate case rather than the one in which the veins have attained the size of a garden hose.

The ulcer which occurs as a by-product of varicose veins, is a common experience and it is usually situated on the lower inner aspect of the leg but may be in any portion of the foot or leg above the plantar pad. They vary greatly in size, duration and in the amount of infection in the surrounding tissue. With the infection from the ulcer we get the damaging of the lymphatics and the accompanying edema; for this reason the ulcer in the edematous leg often appears exaggerated above what it actually is. It is like the picture of the elephant on the child's balloon; when the balloon is distended the elephant is big, but when

the balloon is deflated the elephant is diminutive.

In the literature one often finds objections to sclerosing veins in pregnant women. In order to demonstrate to our own satisfaction the fallacy of the objection we have deliberately sclerosed veins during pregnancy with no accidents from this procedure. Despite this experience, however, we no longer inject the veins in pregnant women because we believe that we are not able during pregnancy to determine definitely what veins will be collapsed after delivery as the dilated veins have a remarkable faculty of disappearing in a large part after delivery. A purely personal factor may also enter into this conclusion. We hold that a woman in the process of preparing a fetus for delivery should not be hampered by any therapy whatever which might be considered elective.

The individual who is suffering from any systemic disease through which he has been rendered an invalid whether it be heart, lungs, kidney, or any other organ, is not a fit subject for therapy. In reference to all other contraindications to therapy we have seen fit to ignore them.

The treatment of varicose veins today has been removed from the operating room; it is no longer considered necessary or advisable to excise varices. This does not mean necessarily that the removal of the offending veins is not desirable, because it is. The disability, hospitalization and loss of time by the operative method, as well as the increased mortality risk to the patient from the procedure, has forced the acceptance of sclerosis in varicose veins as the preferable method of treatment. Many substances have been recommended for the production of the sclerosing effect; doubt-

\* From the Department of Surgery, Long Island College Hospital.

less many of those that we do not mention have great virtue. We have experimented with most of them and for reasons which seem to us proper, we have discarded all except sodium morrhuate 5 per cent and sodium chloride 36 per cent. The morrhuate rarely causes pain at the time of injection; occasionally, after the injection the patient will complain of a severe pain in the region of the lower spine, which lasts five or ten minutes. Apparently this back pain when once it occurs is repeated at every subsequent injection but we have seen no harm come from it. Morrhuate will sometimes give rise to a skin eruption which may cover the entire body or parts of the body and is associated often with edema of the face. It is without doubt anaphylactic in origin; someone has euphemistically termed it morrhuism.

We inject our patients in the standing or sitting position. We use a small needle of No. 22 or 24 gauge. After the material is injected a pledget of alcohol gauze is left over the puncture wound and pressure is maintained for three minutes at the point, the object being to restrict an intensive action of the reagent to a limited area. Despite this precaution, however, we often have this experience; an injection given in the leg gives rise to a sclerosis of the veins of the thigh. In two or three days the sclerosed vein should be both tender and painful, but this wears off. In another day or so the patient is left reasonably comfortable. No disability as regards occupation occurs. Occasionally the extent of the sclerosis of the vein is much greater than was planned and the perivenous infiltration will be 5 or 10 cm. in extent and the entire area so hot, red and painful as to render the patient unable to pursue his occupation for a few days. We have found that a supporting bandage to such an extremity is a great comfort to the patient. It will often permit him to be up and about and perhaps follow his work with a reasonable degree of comfort. During these severe reactions a moderate degree of fever is observed. Although a number of deaths have been

recorded in the literature from the sclerosing treatment of veins, to our knowledge we have not as yet had such an experience.

An individual who has had varicose veins is suffering from a congenital or an acquired condition which for practical purposes is progressive. Because today we remove by excision or sclerosis one group of offending veins is no guarantee that the individual is protected from the occurrence of other varices. We have reviewed our older cases sufficiently to see extensive varices recurrent alongside of fibrous cords which are the remnants of the old sclerosed veins. It is better to forewarn patients that with the recurrence of any varices the treatment should be administered early when the varices are small as it is much easier to sclerose smaller veins than larger veins.

Despite the purpose in the physician's mind in the treatment of varices, many patients come for a motive which is perhaps not so serious. Personal vanity and cosmetic effect enters largely into the determination of the female to rid herself of these disfigurements. Following the sclerosis by some solutions there is a pigmentation of the skin which occurs along the course of the vein; this we have seen repeatedly. It may happen even with the materials we have recommended, but it is believed that it is least likely to occur when these solutions are employed.

Failures by the sclerosing treatment have occurred in our experience from time to time. Some individuals have been injected with every solution in our armamentarium, in every position and by every technique, with no result. Such individuals have a resistant venous intima; one can explain the failure to sclerose in no other way. We have usually closed this disappointing chapter by giving such patients external support. Fortunately, the incidence of these experiences is less than 1 per cent.

The acute phlebitis of infectious origin which occurs frequently in the natural course of events in varicose veins has been treated for generations, one might say, in the conventional manner of rest and eleva-



tion. Because of our experience with artificial chemical thrombosis, we feel by analogy that the infectious thrombosis should be treated by the same ambulatory method. For several years we have practiced support by elastic bandage and mobilization of the patient for bacterial phlebitis of the lower extremity, as soon as the acuteness of the pain would permit that to be done. We have had no accidents or unusual experience as a result of this innovation. The patients, we believe, have been returned to useful activity after a much shorter period of time than was formerly the case.

From time immemorial the ulcer of varicose origin has plagued mankind. The father of medicine, Hippocrates, made the observation that rest in the horizontal position would cure these lesions; modern times has added a host of antiseptics to our therapy. For all these antiseptics and their greasy vehicles we have but one thing to say and that is to condemn them. In the growth of the struggling epithelial cells from the margin of the ulcer there is no pabulum that equals the juices of the body. To administer a cocktail of a mercurial or phenol derivative to struggling epithelial cells is detrimental and can be only detrimental.

The principle of support, achieved by means of a circular elastic bandage, is the procedure we employ. In order to seal the discharges from the wound this bandage is covered on one surface by neutral rubber, latex, in semi-liquid form. This bandage when applied is left in position for several days. The juice that accumulates between the latex and the granulation tissue will be found to be sweet, with little if any odor. Microscopic study will show detritus of disintegrated cells and a scattering of Gram-positive and Gram-negative organisms. Laboratory work on this juice has

shown that it contains bacteriophage. The absence of putrefaction would seem to indicate that there are other bacteriolytic substances present. In this juice the epithelial cells grow well and rapidly, the healing time depending upon the size of the ulcer. In that group of individuals with an associated deep and long standing infectious process, the healing of the ulcer is slow of accomplishment. We find that this is especially true of those individuals of short life expectancy; these patients would be better off hospitalized.

Undoubtedly burden bearing enters largely into the cause of varix and ulcer. People so afflicted are least able to bear extra loads of any kind; overweight has been noted with great regularity, both men and women being victims of this excessive poundage, especially women. Childbearing, overeating, endocrine dysfunction and enforced inactivity from disability all enter into a story told by the scales. One confers a real blessing on these people by correcting their overweight; repair of the veins and healing of the ulcer is hastened and the tendency to recurrence of lesions is greatly reduced. The benefit to the entire body from the reduced amount of work that it has to do each day is definite. Every somatic cell gets a new lease of life. Dieting is a hard struggle but the victory justifies the battle.

#### CONCLUSION

It might be said that we have a simple, safe and rational method for the treatment of varicose veins which has passed well beyond the experimental stage and accomplishes the most rapid and comfortable healing. Also we have a method for the treatment of phlebitis, whether of chemical or bacterial origin, which accomplishes the curing of the patient with greatly reduced disability.



# CLINICAL COMPARISON OF SCLEROSING SOLUTIONS IN INJECTION TREATMENT OF VARICOSE VEINS

## DELAYED SLOUGH; RECURRENCE OF VARICES

ADOLPH A. SCHMIER, M.D.

NEW YORK

ALTHOUGH the efficacy of the injection treatment of varicose veins has been definitely established, I have been repeatedly questioned by physicians regarding the proper sites to begin injecting, the type of solution to use, the possible dangers involved, and the results that can be expected. It was the impression of many that the injection of veins in the upper thigh is contraindicated. The literature also leads one to believe that certain sclerosing solutions are non-toxic systematically and never produce sloughs locally, thereby making these solutions the most ideal. The written reports also lead one to expect a high percentage of recurrences. Since my observations over a number of years do not confirm these impressions, I feel that a résumé of my findings is warranted. In addition, I should like to describe what I call a "delayed or postobliterative slough," a finding which I believe has not been reported. The cases supplying the data for this paper were treated both in the Varicose Vein Clinic at the Brooklyn Jewish Hospital, a branch of Dr. B. Wolfort's Orthopedic Clinic, and in my private practice.

### GENERAL FACTORS INFLUENCING INJECTION TREATMENT

It is a known fact that many patients and even some physicians still regard the injection treatment of varicose veins with suspicion and advise against the procedure. This is due to the immediate or delayed local pain, the systemic reaction due to drug idiosyncrasy, the occurrence of sloughs, and the supposedly high

incidence of recurrences. The general and local factors that determine the success or failure of this form of treatment have been repeatedly reported, and need only to be enumerated. Until recently the two main contraindications to the injection treatment have been an inefficient circulation through the deep venous system, and an acute superficial phlebitis.

*Postobliterative Infectious Phlebitis.* In the past few years I have noted that active foci of infection, even distantly removed, have produced extensive painful obliteration in the veins injected. It is therefore important to postpone injections in patients suffering from upper respiratory infections or other active foci. It is also important for patients who have already had their veins obliterated to guard against all types of respiratory infections. I have had several cases in which a typical infectious phlebitis has been superimposed upon a chemically obliterated vein an invariable length of time following its injection. In 2 of these cases, the patients developed a sore throat and rhinitis just prior to the onset of the phlebitis. In a third case an influenzal bronchitis was present. The veins had been chemically sclerosed from two to six weeks before. It is evident that the recent phlebitis could not have been chemical in origin, but must have been infectious in type, metastatic in origin. This I have termed "postobliterative infectious phlebitis." This is different from the severe, painful phlebitis which occurs within a few days after the injection of a vein in which a latent subclinical phlebitis existed. Tests to determine latent phlebitis have been described in the literature. When these

are positive, injections should be given cautiously and in small amounts. In the cases of postobliterative phlebitis, there

had practically subsided, she was given a second injection of only 2 c.c. of morrhuate. The generalized rash again appeared,

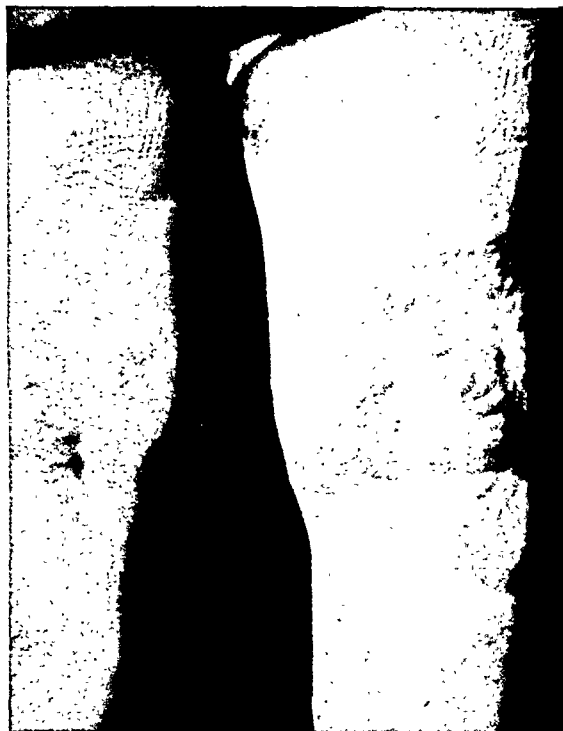


FIG. 1. Type of thin-walled vein likely to produce a delayed slough.



FIG. 2. Same vein three weeks later; note glossy, tense appearance. Delayed slough subsequently formed.

were no evidences of a pre-existing latent phlebitis.

*Drug Idiosyncrasy, Morrbuism.* Another general factor detrimental to the injection treatment is the individual idiosyncrasy to various drugs employed. The accompanying table indicates that of the more common solutions employed, untoward generalized reactions are common with sodium morrhuate, quinine hydrochloride and urethane, and sodium salicylate. I have never yet seen any general reaction following the use of sodium chloride. After the use of sodium morrhuate, several patients developed gastrointestinal upsets with nausea and vomiting. One patient received 3 c.c. of sodium morrhuate and the following day a pruritic rash covered her entire body and scalp. Exfoliation occurred later which lasted more than three weeks. About one month after this injection, when the desquamation

although less marked than previously. The remaining veins were treated with sodium chloride with no untoward effects.

*Cinchonism.* Cinchonism following the use of quinine hydrochloride and urethane has been described in a previous publication. Although ampoules of 2 c.c. are put on the market, I advise against the use of more than 1 c.c. of the drug at one sitting. Dizziness, ringing in the ears, palpitation and gastrointestinal upset have occurred in some of my cases. I have heard of cases of syncope and 2 cases of exitus following its use. I once employed quinine in the treatment of an interne who had innumerable fine thin walled veins. On many occasions from 0.5 to 1 c.c. of the drug was injected with no systemic reaction. Upon the insistence of the interne that larger doses be given in order to hasten the results, I employed 1.5 c.c.



FIG. 3. Another thin walled vein which later formed a delayed slough.

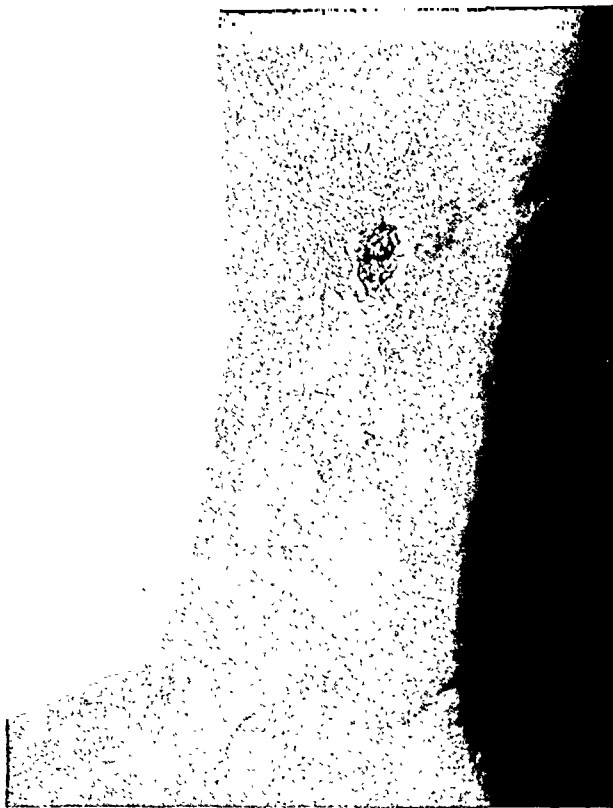


FIG. 4. Delayed slough occurring almost five months after injection.



A



B

FIG. 5. Case 1. Before treatment; A, note large pendulous sac filled with veins; B, lateral view.

of the solution. He immediately developed dizziness and general weakness and was confined to bed for the rest of the day.

drug has not as yet been found. The three drugs mentioned above cannot be considered ideal because of the possibility



FIG. 6. Case 1. After treatment; A, sac only partially contracted; B, appearance following skin plasty.

Quinine is contraindicated during the menses since it may produce menorrhagia. I have had 2 cases where quinine initiated the menstrual flow prematurely.

**Salicylism.** Salicylism has occurred in several of my cases following the injection of 20 to 40 per cent sodium salicylate. In addition to a gastrointestinal upset, a generalized rash has been noted on a few occasions.

The disadvantages of the remaining solutions are recorded in the chart. From the general viewpoint, therefore, it is my belief that sodium chloride is the best and least harmful drug at our disposal. It is important to note, however, that the ideal

of individual idiosyncrasy to them. The remaining solutions including sodium chloride are ruled out as being ideal because of the local disadvantages to be enumerated.

#### LOCAL FACTORS INFLUENCING INJECTION TREATMENT

It should be understood primarily that any drug which is caustic enough to destroy the intima of a vein to produce occlusion, is strong enough to destroy perivenous tissue and produce a slough when injected outside the vein. The reported claims that quinine and morrhuate do not produce sloughs is unwar-

ranted. I have intentionally injected small amounts of every solution subcutaneously and have in each instance produced a slough. Any solution which will not produce a slough when injected perivenously will generally not be strong enough to obliterate a vein. It is folly therefore to look for the ideal solution which never produces a slough. The physician must realize that early sloughs can only be avoided by proper, meticulous technique.

An ideal solution must be one that produces no pain or cramp, is generally non-toxic, and one which causes effective obliteration. According to this definition, none of the drugs in common use is ideal. If the cramp following the injection of sodium chloride could be eliminated, I should consider it an ideal solution. Although sodium morrhuate, quinine hydrochloride and urethane, and sodium salicylate are eliminated as ideal because of the possibility of idiosyncrasy to them, they also fall short because of possible untoward local reactions. Sodium salicylate generally produces a cramp which is more painful than that of any other drug. Although sodium morrhuate generally does not produce an immediate cramp, it does often cause a severe burning, stinging or lancinating pain which begins several minutes after the injection. This pain may last from an hour to several days and often confines the patient to bed. In a busy clinic it is easy for the physician to lose sight of this delayed reaction. The patient has usually left the clinic, and the pain may come on while she is on her way home. At the following visit no inquiry is made regarding any interval discomfort since there was no immediate pain following the last injection. Quinine seldom produces any cramp, although occasionally a patient may complain of mild pain. It does, however, often produce a bronzed discoloration of the skin at the site of injection. This discoloration may last for over two years. In addition, quinine may produce what I have termed a "delayed or postobliterative slough."

*Postobliterative or Delayed Slough.* A postobliterative slough is one which occurs from one to several months after the



FIG. 6. c, lateral view.

injection of a thin walled vein. This vein may be large or small, but it is usually thin walled. Occasionally it may occur in a thick walled vein into which too much solution was injected. It occurs even though the technique of injection is perfect. The solution not only destroys the intima but also the atrophied media and adventitia of the vein wall. Following the injection the vein becomes obliterated and tender. The skin over it may become red, warm and glossy. The destruction gradually advances until after several weeks a slough occurs. With experience, these thin walled, superficial veins that are likely to produce delayed sloughs can be predetermined. Figure 1 presents such a vein on the posterior upper aspect

of the right calf. Figure 2 shows the same vein three weeks after obliteration. The vein is shiny and tense. This site later

appeared, not even did any superficial blister form. Counter-injection with distilled water or 0.5 per cent novocaine



FIG. 7. Case 11. A, before treatment; B, lateral view. Note ulcer at inner left ankle; prominent, thin walled vein on middle third of left calf formed a delayed slough.

broke down. Figure 3 illustrates another such vein on the anterior upper aspect of the left leg. This case also developed a delayed slough. Figure 4 is an example of a delayed slough. A thin walled vein was injected with 1 c.c. quinine hydrochloride and urethane on March 31, 1930, and the slough appeared. On August 25, 1930.

It is important to note that these delayed sloughs are not due to injection of the solution perivenously. When extravasation occurs at the time of injection, the slough forms much earlier. The latter is immediately evidenced by a bluish white discoloration surrounded by a red areola, a sign described in a previous publication. In the delayed slough cases no such sign

solution will prevent the early sloughs but will have no effect upon the delayed slough cases. In my experience quinine has been the chief offender in producing these delayed sloughs. Morrhuate is second although far behind. Any solution presumably can produce these delayed sloughs, although I have only seen them following the use of quinine and morrhuate. In order to avoid these sloughs, milder solutions should be employed when injecting fine veins. I have never seen this complication when 15 per cent sodium chloride solution was used in small doses. Considering the above factors, therefore, it is my belief that sodium chloride is the best solution even from the local stand-

point. If the cramp accompanying its injection could be eliminated, it would be quite ideal. Nevertheless, the cramp

in time and become prominent does not justify the diagnosis of recurrence. These cases were never treated thoroughly in

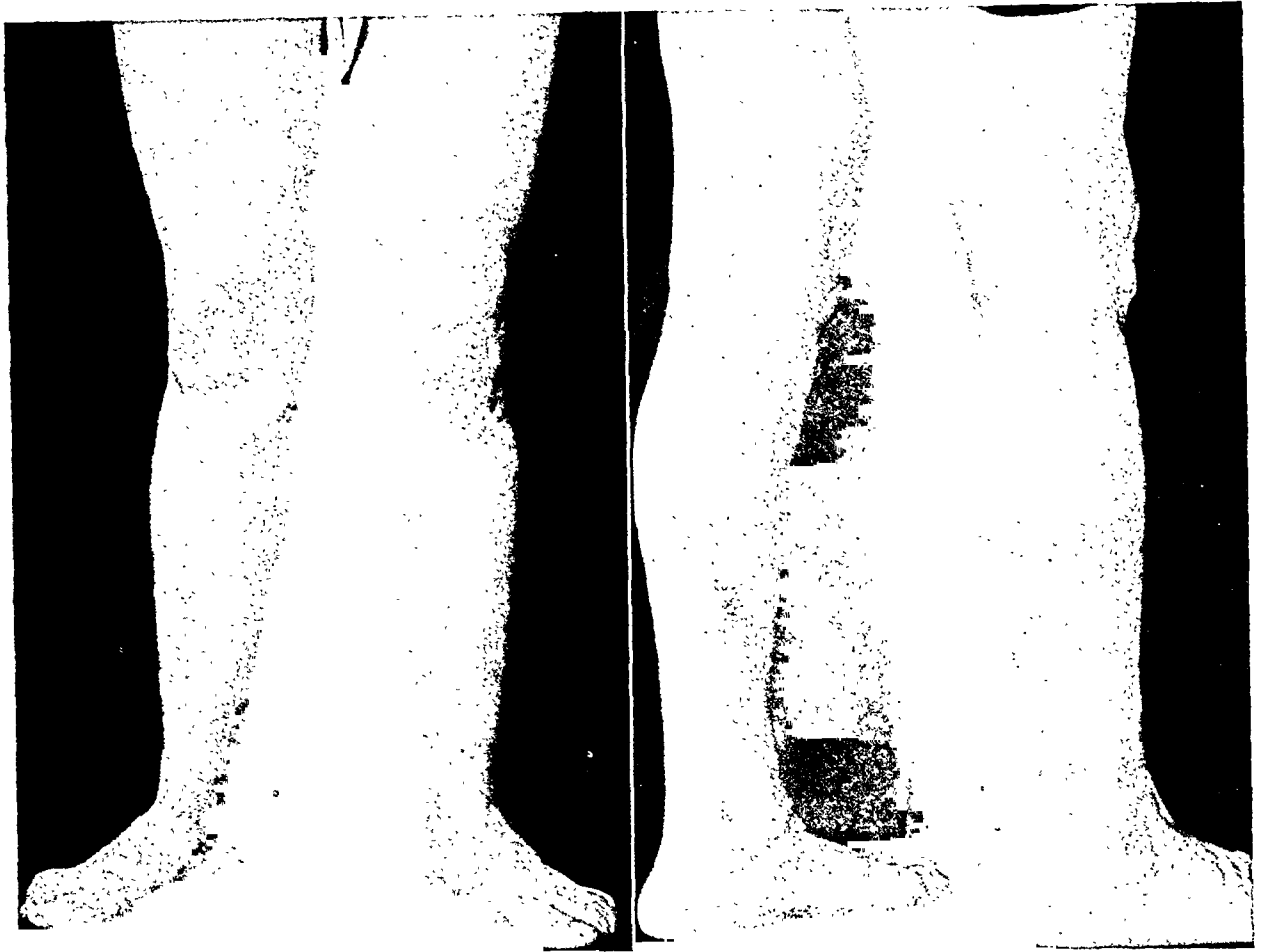


FIG. 8. Case 11. A, after treatment; B, lateral view; ulcer is healed; note delayed slough.

is never as severe as that following the injection of sodium salicylate. In addition, patients who have received both the chloride and the morrhuate injections have expressly preferred the momentary cramp of the chloride to the long, drawn-out pain of the morrhuate.

**Recurrence of Varices.** The opinion that varicose veins recur in the majority of cases is unfounded. I have seen many cases who have received from four to eight injections and who were discharged as cured. The larger and more conspicuous veins were injected, but many smaller visible veins were left untreated. In addition, many untreated invisible veins could be palpated beneath the skin. The fact that these smaller veins enlarge

the first place. Should treatment cease at this point, not only will the smaller veins enlarge but they will also tend to recanalize the few obliterated veins. On the other hand, we must admit that even those cases which are thoroughly treated may develop new varicosities in time.

The infra-red photographs have demonstrated that many veins are present subcutaneously which are neither visible nor palpable. The same etiological factors that originally produced the varicosis may also cause these veins to become enlarged. We know that certain individuals possess a varicose vein diathesis. Otherwise, under similar conditions, why should some people develop varicose veins and



others not? Why should varicose veins appear so regularly in certain families and not in others? Since a good proportion

CASE I. A forty year old woman had enlarged veins distributed over the right thigh and leg and a large pendulous sac filled with



FIG. 9. Case III. A, before treatment; B, after treatment.

of patients with varicose veins display this tendency, we must expect recurrences in them. But these will not appear so rapidly if the original treatment is done more thoroughly. It is important to obliterate the main trunk of the internal saphenous in the thigh if early and extensive recurrences are to be avoided. Often this vein is not visible, but it is usually palpable and can easily be injected. After treatment is completed, I advise my patients to return for inspection every six months, during which time only a few, if any, new veins may be present.

#### CASE REPORTS

The impression that the injection of varicosities in the upper thigh is dangerous is disproved by the report of the following cases.

veins at the level of the saphenofemoral junction. After twenty-four injections the veins were entirely obliterated. Following the disappearance of the veins the pendulous sac near the groin only partially contracted. A skin plastic was therefore performed under local anesthesia.

CASE II. A fifty-four year old woman presented large saccular veins over the right thigh and both legs and an ulcer over the inner aspect of the left ankle. On the middle third of the left calf will be noted a prominent, shiny, thin walled vein, the type in which a delayed or postobliterative slough may occur. This patient required ninety-six injections to obliterate all her veins. The ulcer was treated with metuvit ointment and elastoplast bandage, as described previously. A delayed slough developed several months after the thin walled vein was sclerosed.

CASE III. A middle-aged man with large saccular veins over the right thigh and leg.

The dark area on the inner mid aspect of the leg is due to an old injury and has no relation to the varicosities. Twenty-four injections were required to occlude these veins.

### CONCLUSIONS

Although the ideal solution has not been found as yet, sodium chloride still ranks as the best choice. Any solution that

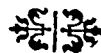
is capable of sclerosing a vein can also produce a slough. Early sloughs can be avoided by proper technique. Delayed or postobliterative sloughs occur in thin walled veins even though the technique of injection is perfect, but they can be avoided by using weaker solutions and smaller doses. Early and extensive recurrences of varicosities can be avoided by more thorough treatment.

### CLINICAL COMPARISON OF SCLEROSING SOLUTIONS

| Solution                               | Amount    | Advantages  | Disadvantages  | Indications for Use                            | Length of Vein Obliterated                  | Occlusion Time  |
|--|-----------|---|--|--|---|---|
| 1. 15-30 per cent sodium chloride.     | ½-10 c.c. | Non-toxic, good obliteration, prompt action               | Cramp, danger of necrosis                            | In all types of veins                          | Varies with individual venous sensitiveness | Varies with individual venous sensitiveness                         |
| 2. 5 per cent sodium morrhuate.        | ½-5 c.c.  | Seldom cramps, good obliteration, prompt action           | Necrosis, local burning generalized rash, g.i. upset | In all types of veins; test for susceptibility | Affected by latent phlebitis                | Different veins in same individual may obliterate quickly or slowly |
| 3. Quinine hydrochloride and urethane. | ½-1 c.c.  | Seldom cramps, good obliteration, prompt action           | Necrosis, cinchonism, starts menses, discolors skin  | Small veins; test for susceptibility           | Average length of occlusion is 1-3 inches   |   |
| 4. 20-40 per cent sodium salicylate.   | ½-5 c.c.  | Good obliteration, prompt action, relieves arthritic pain | Marked cramp, necrosis, salicylism                   | Resistant veins used combined with chloride    | .....                                       | Average time to occlude all veins 10 weeks                          |
| 5. 50-75 per cent invert sugar.        | 2-10 c.c. | Slight cramp  | Necrosis in diabetes, too viscous                    | Large veins non-diabetic                       | .....                                       | Average number of injections—20                                     |
| 6. 50 per cent dextrose...             | 2-10 c.c. | Slight cramp  | Necrosis in diabetes, action weak                    | Smaller veins combined with 30 per cent NaCl   |   |   |
| 7. Varicosmon.....                     | 2-10 c.c. | Seldom cramps   | Necrosis; too viscous                                | Large veins                                    |   |   |

### REFERENCES

1. CARTER, R. M. The injection treatment of varicose veins. *Am. Jour. Surg.*, 8: 551, 1930.
2. COLT, G. H., RAMSAY, I. S. W. and MORRISON, N. Injection treatment of varicose veins: late results; question of recurrence. *Brit. Med. Jour.*, 2: 49, 1935.
3. DETAKATS, G. Injection treatment of varicose veins: causes of failure. *J. A. M. A.*, 96: 1111-1114 (April 4) 1931.
4. HOWARD, N. J., JACKSON, C. R. and MAHON, E. J. Recurrence of varicose veins following injection. *Arch. Surg.*, 22: 353, 1931.
5. JACQUES, L. Varico-phlebitis and the injection treatment. *Ann. Surg.*, 95: 746-753 (May) 1932.
6. JENSEN, D. R. Varicose veins and their treatment. *Ann. Surg.*, 95: 738, 1932.
7. LEWIS, K. M. The injection treatment of varicose veins. *Ann. Surg.*, 95: 727, 1932.
8. MCPHEETERS, H. O., MERKERT, C. E. and LUNDBLAD, R. A. The injection treatment of varicose veins: causes of failure. *J. A. M. A.*, 96: 1114-1117 (April 4) 1931.
9. PAYNE, R. T. Infra-red photography of superficial venous system. *Lancet*, 1: 235, 1934.
10. SCHMIER, A. A. Sclerotizing injections in varices of the lower extremities. *J. A. M. A.*, 94: 1222, 1930.
11. SCHMIER, A. A. Treatment of varicose ulcers. *Am. Jour. Surg.*, 23: 195, 1934.
12. TUNICK, I. S. and NACH, R. Sodium morrhuate as a sclerosing agent. *Ann. Surg.*, 95: 734, 1932.
13. TUNICK, I. S., DUBIN, S. and SCHMIER, A. A. The injection treatment of varices and ulcers of the lower extremities. *Am. Jour. Surg.*, 6: 479, 1929.



# AMBULATORY SAPHENOUS LIGATION

## REPORT OF 100 CONSECUTIVE CASES\*

STUART Z. HAWKES, M.D. AND IRVING P. BORSHER, M.D.

NEWARK, N. J.

IN the treatment of varicose veins, ligation of the saphenous vein in the thigh has gained a definite place of importance, in those cases where the valves of the long saphenous vein have become pathological and fail to function. Because of this fact, there is a backflow of blood in the vein toward the foot, due to the erect position of the body and caused by gravity. It is thought that some varicose veins may result solely from the insufficiency of these valves. In any event, in this condition there is a flow of blood down toward the foot, then through the communicating veins into the deep circulation, and up the deep femoral vein to the iliac vessels. As the long saphenous vein joins the femoral vein at this point, and because of valvular deficiency, some of the venous blood may again enter the saphenous vein and descend toward the foot, reaching the deep circulation once more through the communicating veins. If such a cycle is considered in toto, it is apparent that all of the blood does not continue toward the heart, some again completing the pathological circuit many times by dropping downward in the saphenous vein, causing back pressure, stasis and dependent edema. This type of pathology is known as Trendelenburg positive veins.

A similar pathological circuit is developed in the leg posteriorly, when the valves of the short saphenous vein fail to function. There is a backflow of blood at the point where the small saphenous vein joins the popliteal vein in the popliteal fossa. In the erect position, with Trendelenburg positive veins, there is a column of blood from the right side of the heart down through the inferior vena cava, the iliac vein, the femoral vein and finally the incompetent saphenous vein to the foot. This

column of blood, because of its weight, exerts pressure against the wall of the saphenous vein and its tributaries, causing these veins to widen and become varicose. It is the purpose of ligation of the saphenous vein to interrupt this column of blood, thereby removing its pressure on the varicose veins below the level of ligation.

When the treatment of varicose veins by injection was revised and tried again a few years ago, a number of patients returned with recurrences after several months, following an adequate course of treatment. With these facts in mind, the mechanics of the circulation were studied, and ligation of the saphenous vein was added to the treatment in order to prevent the recanalization of veins thrombosed by injections. The recanalization took place as a result of the incompetence of the valves of the saphenous vein, and due to the pressure of the column of blood described.

After this fact was established, in this clinic ligations were taken up in conjunction with the injections as part of the routine treatment of this type of veins. At first the saphenous vein was ligated in the lower part of the thigh, but more experience showed that new veins would form and continue around the site of ligation, resulting in new varicosities or the return of some old ones. The ligation is now done in the thigh as high as possible, although it can be done no higher than the vein can be followed because the anatomical relationships are not constant. Some authorities advise routine ligation at the end of the long saphenous vein (i.e. just below Poupart's ligament), but we feel that such a procedure will lead to a certain percentage of failures because the vein occasionally drops into Hunter's canal below the fossa ovalis.

\* From the Varicose Vein Division, Peripheral Vascular Clinic, Presbyterian Hospital, Newark, N. J.

This series of ligations was done in the out-patient department as we feel that hospitalization is unnecessary with the technique employed. This fact is important economically, as most of the patients treated in the clinic could not afford to leave their homes or to pay a hospital bill. They leave the clinic soon after the ligation and many or most of them have continued their day's work. Some have complained of tenderness for several days, and one or two only have had to be confined at home for several days.

The first ligation of this series was done in November, 1935, covering approximately a period of three years. Since the middle of 1934 nearly all the saphenous ligations have been high in the thigh. Those before that time were in the low or mid thigh.

Table I shows the advantages of high ligation, as was learned from these patients on return visits at three and six months after completion of treatment. It will show the advantage of interrupting the circulation as high as possible in the thigh. Table II gives the summary of the location

| TABLE I            |                     |                       |                     |
|--------------------|---------------------|-----------------------|---------------------|
| Location           | Number of Ligations | Number of Recurrences | Per Cent Recurrence |
| Lower thigh.....   | 10                  | 3                     | 30                  |
| Mid thigh.....     | 29                  | 12                    | 41                  |
| High ligation..... | 61                  | 0                     | 0                   |

| TABLE II             |      |        |       |
|----------------------|------|--------|-------|
|                      | Male | Female | Total |
| No. of Patients..... | 15   | 47     | 62    |
| Right thigh.....     | 12   | 47     | 59    |
| Left thigh.....      | 6    | 35     | 41    |

and sex. It will be noted that 59 per cent of the ligations were performed in the right thigh. This is an interesting fact as varicose veins are supposed to be more frequent in the left leg, owing to the anatomical distribution of the iliac veins and causing

higher pressure readings in the veins of the left leg. The ratio of female to male patients is about 3:1.

CLINICAL PROCEDURE

On admission to the clinic a complete history is taken of the patient's complaints, past medical and surgical history, paying special attention to the obstetrical, past injuries, phlebitis, typhoid, and family history. Knowledge of a past postpartum thrombophlebitis or milk-leg, typhoid, or severe injury may lead us to suspect deep venous involvement. The family history frequently reveals the presence of varicose veins in several members of the family as an hereditary tendency.

A complete physical examination is made, the urine examined, and a Wassermann test is made. Abscessed teeth and infected tonsils are ruled out as foci of infection for recurring phlebitis. Cardiac decompensation or chronic nephritis are excluded as the cause of edema of the lower extremities. A patient with diabetes will need to be controlled before treatment is started, but can be readily and safely treated after regulation has been accomplished. Pelvic examination may reveal an inflammatory exudate or tumor as a possible etiological factor in producing vein pathology. An allergic patient with varicose veins and a weeping eczema may have to be desensitized in combination with treatment of the veins. What appears to be a varicose ulcer may prove to be syphilitic and require some form of anti-luetic treatment.

Diagrams are then made of the lower extremities, charting the location of varicosities, ulcers, pigmentation and edema, together with accurate measurements of differences in size of the legs. These diagrams are of assistance in following the progress of the case and in reviewing the original pathology in the future.

The veins are examined by means of the Trendelenburg tests to determine the type of varicose veins present and whether the deep venous circulation is involved. The cases for ligation are thus chosen on admis-

sion to the clinic and ligation is done before any other treatment is given, unless a dirty ulcer or infection is present. In such a case ligation is deferred.

The tests for Trendelenburg positive veins and involvement of the deep venous circulation are made in a practical way. If the valves of the saphenous vein are entirely incompetent (Trendelenburg positive), an impulse will be transmitted upward through the whole length of the vein by percussing the varicosities in the leg. With the patient standing, the prominent veins in the leg and thigh are percussed with the fingers of one hand, and the impulse that is transmitted upward may be palpated over the saphenous vein in the thigh with the fingertips of the other hand. In this way the course of the saphenous vein can be traced to its upper limit (in almost all cases at the fossa ovalis), and the position of the vein in the upper thigh located accurately. Similarly, an incompetent small saphenous vein in the posterior leg can be traced to the popliteal fossa.

The deep venous return is tested by placing a tight flannel bandage about the patient's leg from the toes to the knee. This is tight enough to constrict the superficial veins. If the deep venous circulation is occluded, the patient will experience some pain in the leg and foot in ten to fifteen minutes, together with swelling and cyanosis of the foot. The patient walks about with the bandage for several hours, and if comfortable, the deep venous circulation is considered competent. This precaution seems important, as 3 cases have been seen with deep venous occlusion. If deep venous involvement is found, then ligation or injection of the superficial veins is contraindicated, as these veins are compensatorily enlarged, and any radical treatment would only lead to edema, more varicosities, or possibly serious trouble. The treatment in such cases consists of rest, frequent elevation of the lower extremity, and support with an elastic bandage.

The patients return to the clinic for treatment at weekly intervals. After the course of treatment is completed, the

patients return to the clinic for follow-up at the end of one month, then three months, and finally at six months intervals.

#### TECHNIQUE OF LIGATION

With the patient standing, the level of ligation is determined by percussing the lower end of the varicose vein and palpating the impulse transmitted upward in the vein. The incompetent vein is nearly always the saphenous vein, although anomalous veins are occasionally found and ligated. The impulse can usually be traced to the fossa ovalis. The level of ligation is the highest point at which the impulse can be felt. In most cases this point is about 1 to 1½ inches below Poupart's ligament.

The level of ligation is marked with a stain on the skin overlying the vein, as the vein cannot be felt in the reclining position. This simple precaution will localize the vein and save much later hunting. The stain is applied in the form of a cross or plus sign, with the horizontal line denoting the level of ligation and the vertical line showing the long axis of the vein.

The patient then lies down on the table. The skin in the operative area is shaved. Iodine and alcohol are used on the skin.

Novocain solution 1 per cent is injected along the line of incision and a one inch long incision is made at right angles to the course of the vein, using the horizontal line of the stain as a guide. The subcutaneous fat is bluntly dissected with Kelly clamps. If the exact line of the vein has been determined, the vein will frequently be seen or felt beneath the superficial fascia. The vein is found lying superficial to the deep fascia. It is advisable to dissect slowly and carefully, and to use only blunt-nosed clamps, since the wall of the vein is frequently very thin or varicose even at this level, and can be easily pierced or torn.

The exposed vein is carefully dissected from its bed and freed for about one inch. The vein is lifted out of its bed, doubly clamped, and cut between clamps. Care is taken to leave enough cut vein beyond the clamps to prevent the edge of the vein from slipping through the clamp. In obese pa-

tients, where the vein is under tension, the extra precaution is taken of tying the vein proximal to the clamps before it is cut, to

due to the position of the vein in fatty tissue.

The wound is inspected for bleeding and

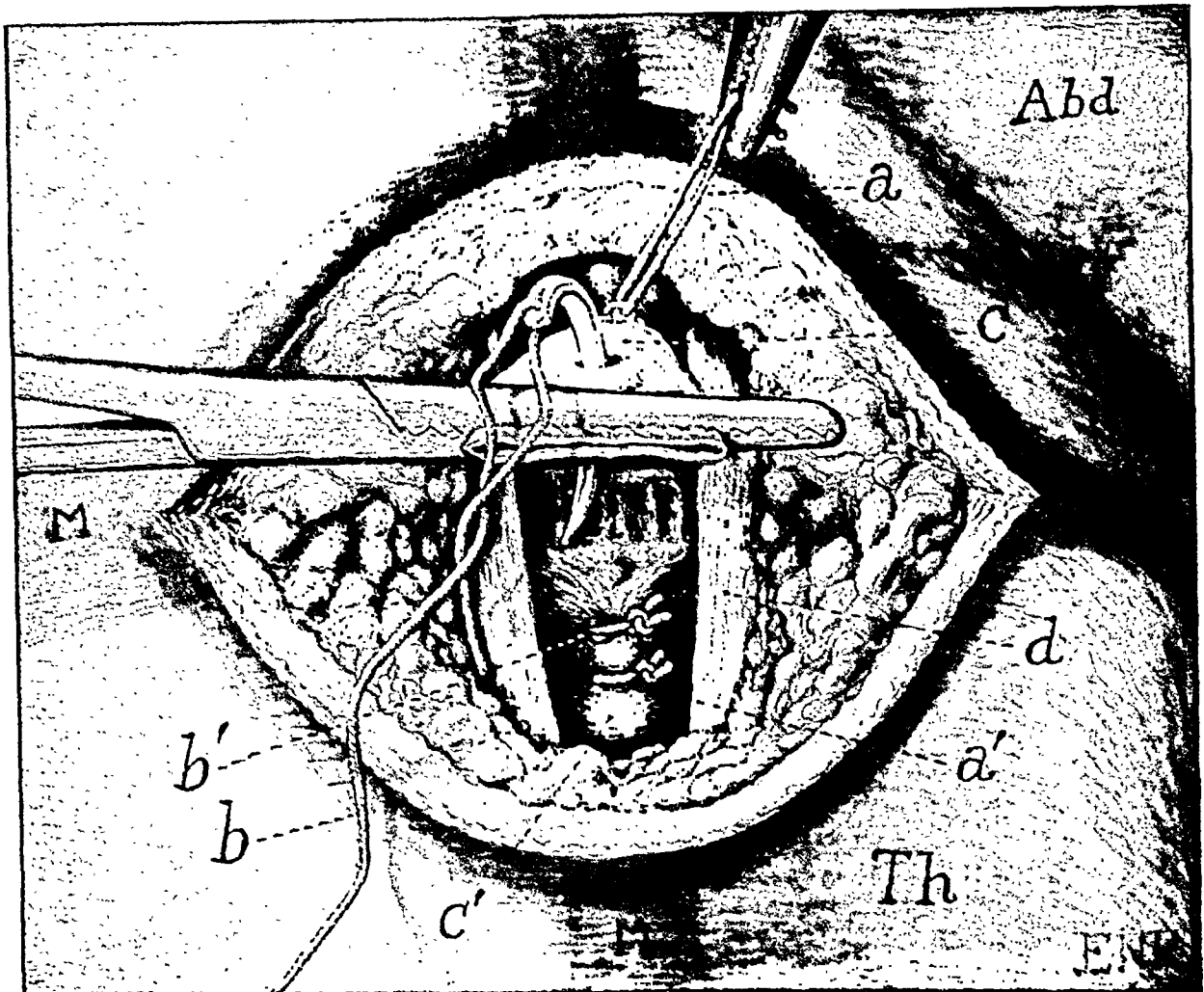


FIG. 1. a, a', first ligature placed; b, b', second transfixion ligature, upper end on needle; c, c', upper and lower ends of cut saphenous vein; d, superficial fascia; M, skin marking with dye to show vein position; Th, thigh; Abd, abdomen.  $\frac{1}{2}$  (X 2.)

preclude any possibility of losing the cut end. If lost, the cut end drops quickly out of sight, and requires much extra time and extreme care in recovering it without extensive blood loss. This complication occurred in one case previous to this series.

A ligature is tied proximal to the clamp as high as possible, and then a transfixion suture is placed between ligature and clamp, as shown in Figure 1, following the same procedure for both segments of the vein. The ligature and suture material is No. 1 plain catgut. The use of heavier catgut has been tried but was found to cause induration or sterile pus formation,

then swabbed with ether in order to cut down as much as possible on possible contamination. It is not necessary to close the fascia or attempt approximation of tissues beneath the skin. The less catgut used beside the vein, the better. The skin is closed with horsehair in mattress sutures, without drainage. The wound is covered with gauze saturated with alcohol, and strapped tightly with adhesive strips about 8 inches long.

The patient is allowed to stand and walk about immediately, but is detained in the clinic for about half an hour, to be observed for weakness, fainting or any untoward reaction.

The transfixing of the vein (Fig. 1) we feel removes much of the hazard of ambulatory ligations as far as bleeding is concerned. With this technical point included, it is impossible for either end ligature to slip off the vein, as the transfixion tie is placed between the previous ligature and the cut vein end.

#### COMMENT

1. The treatment is entirely ambulatory. The patient walks immediately after ligation and is not confined to bed. Some of the ligations have been done on elderly people, seventy and eighty years old and they have done as well as the younger patients. It is remarkable to see varicose ulcers of several years duration in both middle-aged and elderly people, close within three to five weeks after ligation. The diminution in pain and swelling is rapid, the ulcer granulates and is covered with epithelium quickly.

2. Several cases have had simultaneous bilateral saphenous ligation without difficulty, and ambulatory. At first we were hesitant to do both extremities at the same time. However, we had encountered no complications with single ligations, and therefore felt we should try ligating both extremities at one time.

3. The site of ligation is not determined anatomically, but by tracing the impulse in the saphenous vein, otherwise difficulty or failure to locate the vein may result. At first there may be difficulty in palpating the impulse in the thigh, but with practice the tactile sense is developed rapidly.

4. In ligation of the long saphenous vein it is necessary to ligate close to the fossa ovalis and above the site of the circumflex branches (superficial circumflex iliac, superficial epigastric, external pudendal, lateral femoral cutaneous, accessory saphenous veins), or there will be recurrence by enlargement of one of these. This is borne out by the figures in Table 1, which shows that ligation in the low or the midthigh was followed by recurrence above the site of ligation.

5. The skin sutures remain two weeks to insure complete healing of the skin and avoid breaking down of the wound. With the patient ambulatory, the wound edges are subjected to a pulling force.

6. The varicose veins are not injected for two weeks following ligation in order to allow the veins to contract of themselves after removal of the pressure of the column of blood. This makes for smaller thrombosis, better cosmetic results, and less injections. We use two sclerosing solutions, sodium morrhuate and a sodium chloride-dextrose solution, the latter for the larger veins and the former for the smaller veins. Caution is necessary in the use of the sodium chloride-dextrose solution, for any injection outside of the vein results in severe pain and necrosis. Therefore it is advisable to use a short bevel needle and to inject only the larger veins with this solution. Other more drastic and toxic solutions are reserved for the occasional refractory case.

7. In case of ligation for varicose ulcer, the ulcer is rendered clean of infection before ligation. Frequent hot, moist magnesium sulphate dressings are applied to the ulcerated area for one or two weeks, along with rest and elevation of the limb, and elastic bandage. There is thought to be a lymphangitis and a lymphadenitis of the superficial subinguinal nodes draining the infected ulcer, and ligation of the saphenous vein in this area before the ulcer is clean may result in a cellulitis or thrombophlebitis in the thigh.

#### CONCLUSIONS

1. Ligation of the saphenous vein in the low or midthigh is followed by recurrence above the site of ligation.

2. No recurrence has followed ligation of the saphenous vein at the fossa ovalis in those cases followed to date.

3. The whole treatment may be carried out with the patient entirely ambulatory.

4. Simultaneous bilateral ambulatory ligation has been done without succeeding difficulty.

# ARTIFICIAL PNEUMOTHORAX

## PRACTICAL ASPECTS OF ITS APPLICATION TO PULMONARY TUBERCULOSIS

EDGAR MAYER, M.D.

AND

MARTIN DWORKIN, M.D.

Assistant Professor of Clinical Medicine,  
Cornell University Medical College

Physician to Out-patient Department,  
Gouverneur Hospital

NEW YORK

THE application of artificial pneumothorax, air or gas introduced into the pleural cavity, to the treatment of pulmonary tuberculosis constitutes one of the major medical advances of the past half century. With this treatment, many patients who would otherwise be undergoing prolonged confinement to bed at home or in sanatoria, are able to resume exercise and occupations much sooner while the lung is still healing. Collapse of the lung by artificial pneumothorax has become a universally accepted procedure. Through it the toxic effects of the disease are controlled, spread of infection to the hitherto unaffected lobes or to the opposite lung are prevented, and healing is hastened, so that prolonged bed rest is less necessary.

Twenty-five per cent of patients with pulmonary tuberculosis who were admitted to institutions during 1934 received initial pneumothorax treatment the same year. The increasing use of pneumothorax may be correlated with the continuous and marked fall in mortality and morbidity rate of pulmonary tuberculosis during this century. In New York State the death rate for pulmonary tuberculosis has dropped from 124 per 100,000 in 1919 to 51.8 in 1934. It has been estimated that 77 per cent of all cases today are undergoing some form of collapse therapy. Pneumothorax accomplishes economic recovery in 40 to 50 per cent of cases receiving it under the usual indications.<sup>1</sup>

The greater saving of lives occurs in cases with cavity in whom this therapy is instituted. Without its aid reported figures are appalling. Figures from the Trudeau

Sanatorium at Saranac Lake are significant. In cases with cavity and disease of far advanced extent, without pneumothorax, death occurred in 69 per cent at the end of five years. Even more ominous are figures from studies made among patients of poorer economic circumstances with more extensive and destructive type of pulmonary pathology.

### INDICATIONS

Pneumothorax is almost always indicated before an attempt is made at more radical surgery. A patient with a positive sputum and a recently developed tuberculous cavity of moderate size, about 2 cm. to 4 cm. in diameter, which persists with little favorable change despite a few weeks of bed rest should have the lung collapsed without delay in the absence of definite contraindications. Cavities of older age or of larger size, resultant from sloughing in caseous pneumonias usually indicate immediate attempt at collapse. Hemoptysis, tuberculous laryngitis, and moderately advanced tuberculous enteritis are no longer considered contraindications. By collapsing the diseased lung and closing the cavity itself, the source of production of tubercle bacilli is eliminated and the complications tend to cure.

Progressive phthisis calls for early establishment of pneumothorax to localize the lesion, when spontaneous arrest is unlikely after a brief period of observation, arbitrarily for three weeks. It should be established without delay when the process is of the acute caseous pneumonic character to combat prostrating toxemia and exhaustion, even if one anticipates progressive cavernous sloughing of tissue.

<sup>1</sup> MAYER, E. Cavity in the tuberculous, its management. *J. A. M. A.*, 100: 1478 (May 13) 1933.



The "allergic" or so-called exudative type of tuberculosis, often found as the subapical infiltrate, deserves careful watching for a few weeks under strict bed rest before pneumothorax therapy is instituted. This type of disease often resolves spontaneously. If not, it may go on to rapid excavation or extension. Any evidence of such change immediately calls for collapse therapy.

In Negroes who are prone to softening and liquefaction of caseous foci, particularly those in poor economic circumstances, pneumothorax should be instituted early. Patients without means to provide sanitary surroundings, good food and fresh air as is commonly the case in the dwellers of tenement districts of large cities, are less likely to spontaneous arrest of the tuberculous process than are those of more fortunate means, so that economic factors often force immediate institution of collapse therapy.

There are some workers who look upon even active minimal pulmonary tuberculosis with positive sputum as an indication for immediate artificial pneumothorax. However, considering the complications of pneumothorax, such as effusion, tubercularization of the pleura, empyema and bronchial or subcutaneous fistula, all early cases should not indiscriminately receive pneumothorax.

Pregnant women with active tuberculosis should have their disease put under control of pneumothorax during pregnancy if the disease is not of a productive nature. In even extensive exudative unilateral disease, pregnancy is often well tolerated if supported by pneumothorax.

In children and adolescents, existence even of a minimal pulmonary tuberculosis usually requires early induction of pneumothorax. It must not be forgotten that the open case is, from the epidemiological standpoint, a menace to the community.

#### CONTRAINDICATIONS

There are a few contraindications to the institution of pneumothorax. In the main they are cardiopathy, cardiovascular-renal

disease, asthma, severe emphysema with marked reduction of vital capacity, and perhaps advanced bilateral tuberculosis with both lungs active. However, in cases with bilateral cavitation, institution of pneumothorax on the worse side may improve the lesser involved opposite lung and subsequent pneumothorax may be instituted for the contralateral lesion. Terminal enteritis and advanced laryngitis present contraindications to pneumothorax. Diabetes is not a contraindication but on the contrary, is an indication, though here the metabolic disorder must be carefully controlled.

*Physiology and Dynamics of Pneumothorax.* Normally there is always a negative intrapleural pressure of minus 4, minus 8 c.c. of water in expiration and inspiration, respectively, which is maintained by the pull of smooth muscle and elastic lung fibers contracting concentrically about the hilus or the center of gravity of the lung. Intra-thoracic or intrapleural pressure is equivalent to intrapulmonic pressure minus the elastic pull of the lung. This pull is greater on inspiration than expiration so that the lung follows the expanding thoracic cage in response to the inflating force of normal atmospheric intrapulmonic pressure. This ballooning force along with negative intrapleural pressure and cohesive attraction between visceral and parietal pleural layers keeps the expanding lung in even contact with the chest wall and diaphragm. On introducing air between the pleural surfaces, the pull of the chest wall and diaphragm is progressively decreased as the negative intrapleural pressure is lessened. The lung is permitted to contract, and as the intrapleural pressure approaches zero, the lung continues to contract until it is completely collapsed and quiescent.

In regions of diseased lung parenchyma, with infiltrations, fibrosis, or cavities, there is increased elastic tension of lung tissue and lessened expansibility by respiratory pressure changes and consequently retraction of these parts occurs to a greater extent than normal tissue. In the absence of

adhesions inserted over the lesions, these parts are selectively put at rest while healthy lung continues to function. A selective or "hypotensive" collapse is the most ideal type of pneumothorax and is preferable to complete immobilization of the lung by positive intrapleural pressure.

Most important among factors cited as responsible for healing under pneumothorax are, (1) partial or complete rest of the collapsed lung, (2) release of elastic tension of the lung, (3) production either of pulmonary hyperemia or ischemia. Four-fifths of the air introduced in pneumothorax exerts an expanding force on the mobile thoracic cage, while only one-fifth acts to reduce lung volume. This and the expulsion of residual air from the compressed lung as well as the collapse of non-functioning parenchyma account for the very slight reduction of lung volume with pneumothorax therapy.<sup>2</sup> Spirographic measurements show that the vital capacity after collapse is not decreased in proportion to the amount of air insufflated. Thus, the collapsed lung continues to move and ventilate with very little diminution caused by pneumothorax, except in positive pressure pneumothorax or with pleural effusion and pleural fibrosis with paradoxical diaphragmatic motion, in which events the lung is immobilized. With an easily shifting mediastinum, the collapsed lung does not ventilate but moves as a mass with respiration. There is no interference in uncomplicated pulmonary collapse with normal oxygenation of arterial blood. In bilateral pneumothorax the two collapsed lungs maintain normal gaseous exchange.

Coincidentally, there is slowing of lymphatic circulation and toxemia and the tendency of the disease to spread is lessened. Rather than ischemia there is increased congestion and venous stasis of the lung<sup>3</sup> with impaired distensibility so

that healing and fibrosis are promoted. Rarely, bronchial stenosis with atelectasis may be a factor though postmortem evidence for this is wanting.

Release of elastic tension by pneumothorax relieved the disease bearing area from the strain of continuous respiratory movement.

Spread of disease in the collapsed lung is extremely rare. This is true of hematogenous, as well as lymphatic and bronchogenic forms of dissemination.

#### PROCEDURE

*Substance Injected.* Filtrated air is commonly used as it is most satisfactory and practical. It has the obvious advantages of being readily available and absorbing slowly enough to obviate too frequent replacement.

*Equipment* should be simple and need not be expensive. A simple apparatus of the type illustrated may be installed with or without cabinet at very little expense, for office or bedside use (Fig. 1). It consists essentially of a water manometer, A, for registering intrapleural pressure. By means of a pinch-cock or two-way stop-cock, B, this may be shut off while air is administered from bottle C. By reversal of the petcock, the flow of air may be interrupted and readings taken at intervals during the administration. From bottle D water colored with green chlorophyll flows by gravity into bottle C through the connecting tubing, E, the amount entering bottle C displacing an equivalent volume of air along the tubing, F, into the thoracic space through pneumothorax needle, G. By simply reversing the bottles air may be withdrawn from the pleural cavity.

Clinical observations and experience of many workers, supplemented by mathematical computation and consideration of the physical principles involved, have been embodied in the preparation of standards and specifications for construction of artificial pneumothorax apparatus recommended by the Committee on Artificial

<sup>2</sup> PINNER, MAX. Mechanisms of healing in collapse therapy. *Ann. Int. Med.*, 9: 501 (Nov.) 1935.

<sup>3</sup> CHRISTIE, R. V. Pulmonary congestion following artificial pneumothorax; its clinical significance. *Quarterly Jour. Med.* (Aug.) 1936.

Pneumothorax of the American Sanatorium Association.<sup>4</sup>

The calibre of the pneumothorax needle

Too fine a needle hinders satisfactory manometric oscillations. The needle lumen may be too readily obstructed by water



FIG. 1.

recommended is 17 to 20 gauge Luer (0.8 to 1.2 mm. in diameter), average 18 to 19 gauge Luer (or about 1.0 mm. diameter), and 2 to 2½ inches long. For the initial insufflation of air, the larger calibre is desirable, with a short or blunted bevel.

<sup>4</sup>PETERS, A., POPE, A. S., CRAMER, J.: Manometric readings of intrapleural pressures in artificial pneumothorax. *Am. Rev. Tuberc.* 34: 614 (Nov.) 1936.

from the sterilizer or by anesthetizing fluid if the syringe has been attached, or by a tiny bit of extrapleural tissue picked up on the way into the pleural cavity. A needle length sized sterile stylet should always be handy to free the needle track under these circumstances.

The manometer and connecting tubing should be 3 to 5 mm., but averaging 4 mm.,

in diameter. Smaller bore than this is not desirable as capillary force may cause the water column to break. Connecting tubing should be of sufficient length to extend from the outlet of the pneumothorax apparatus to the needle when inserted into the patient's chest. It should be as short as feasible.

The intelligent use of the manometer ranks in importance with that of the radiograph machine and fluoroscope as a guide in pneumothorax practice. Best adapted for ordinary use is the U-tube type of water manometer calibrated 15 to 20 cm. in height above and below the zero mark. To facilitate direct reading of correct pressure, the scale should be marked off in half centimeters, each graduation being cardinally numbered and read in terms of centimeters of intrapleural pressure. If marked in centimeters directly the reading obtained must be corrected by doubling the figure. Coloring matter to aid reading, such as powdered chlorophyll or fuchsin may be used, through the vegetable dye is preferable as it is less apt to stain the glass with prolonged use.

#### TECHNIQUE

The patient should be placed lying on the good side with a small pillow under the dependent thorax in order to stretch apart the intercostal spaces on the uppermost or affected side. This position affords widest respiratory and manometric excursions. With the patient turned on his back, intrapleural pressures are higher due to the rising of abdominal viscera and diaphragm, diminishing the size of the hemithorax.

The rib interspace selected for the site of introduction of the needle is determined by the location of the disease. There is more likelihood of finding free pleural spaces and less likelihood of puncturing diseased lung tissue when the needle is introduced at some distance from the area of disease. Ordinarily the optimal site is the seventh or eighth interspace in the posterior axillary line, well below the scapular angle. For

refills it makes no difference where the needle is inserted as long as there is good collapse and the needle is introduced at some distance from the attachment of adhesions to the chest wall as previously visualized by fluoroscopy or oblique roentgenography. In difficult cases, pneumothorax may be best administered under fluoroscopic guidance. Before the attempt is abandoned, several different sites may successively have to be tried when free pleural space is not found at the initial site selected.

In office practice we have not found necessary the adoption of formal hospital routine ordinarily used in preparation for major surgery. However, though we dispense with sterile gown and gloves and draping of the patient, meticulous asepsis is wise to obviate exogenous infection of the pleural cavity. The happier psychologic effect on the patient when the procedure is simple and unostentatious is not to be undervalued.

Tincture of iodine, 3.5 per cent, is applied over the selected site and the excess removed with alcohol. Using a 25 gauge,  $1\frac{1}{2}$  inch needle, an intradermal bleb is first made and through this the skin and subcutaneous tissues are infiltrated with 2 per cent procaine solution, down as near as possible to the parietal pleura. The novocaine is introduced as the needle follows close to the upper border of the lower rib, avoiding intercostal vessels and nerve.

After a few minutes the short beveled "initial pneumothorax needle" which is still attached to the novocaine-containing syringe, is inserted at a safe angle of 45 degrees with the body surface. As the parietal pleura is entered the easily movable plunger descends, permitting the suction of the negative intrapleural pressure to draw novocaine into the pleural cavity.

When this happens, the syringe is detached and the needle connected with the tubing to the manometer. With the patient breathing quietly and the needle in the pleural cavity a negative pressure minus 4 cm. water on expiration, minus

8 cm. water on inspiration will be indicated on the manometer with good respiratory oscillations. Slight oscillation of the manometer around the atmospheric level may occur with the needle just outside the parietal pleura. When a proper reading is obtained, insufflate 25 c.c. of air. Take frequent readings while giving the first 50 c.c. to preclude the possibility of the needle tip, originally intrapleural, having penetrated the lung. If the pressure is still negative introduce 50 c.c. more, continuing with small amounts periodically administered until about 200 to 300 c.c. have been introduced. The instillation should be ended with a mean negative intrapleural pressure.

Within forty-eight hours a refill is given insufflating in like manner small amounts of air with periodic manometric readings until 300 c.c. are given, leaving as before a negative intrapleural pressure. A third refill is given two to three days after the second, a fourth four to five days after the third, and subsequent refills at weekly intervals. As the degree of collapse increases, in the absence of restraining adhesions, patients may have refill intervals prolonged to ten days, to two or three weeks and more. Patients should be kept in bed for several weeks during the establishment of pneumothorax.

A definite routine should be followed in carrying out pneumothorax treatments. Refills should be frequently given, introducing amounts requisite for obliterating as promptly as possible all excavation and splinting satisfactorily the whole lesion with conversion of sputum from positive to negative. At this point only may we be assured the patient has a clinically effective pneumothorax. When symptoms and signs of activity have disappeared, the lung should very slowly and gradually be allowed to reexpand ideally to a state of selective collapse. Thus by the second or third year of treatment, the depth of collapse of the disease bearing portion may be maintained at about 10 to 20 per cent, with the remaining healthy lung actively functioning in respiration.

When no adhesions are present the desired degree of collapse may be attained without the use of positive intrapleural pressures. In the presence of adhesions, particularly those suspending a stiff-walled cavity in the disease bearing area, positive pressures are justified in order to stretch the adhesions and permit cavity closure and negative sputum. Tension pneumothorax often obviates adhesion cutting. High positive intrapleural pressures are to be used with caution as there is danger of tearing caseous foci present in the lung adjacent to the attachment of the tensed adhesion.

The patient is instructed to lie on the treated side between refills in order to prevent infected sputum from being aspirated into the bronchi of the opposite lung.

*Laboratory Aids to Management of Pneumothorax.* Monthly sputum examinations should reveal a progressive reduction of bacillary content to the point of conversion to negative. The rate of disappearance of bacilli from the sputum depends upon the presence or absence of pleural adhesions on the treated side or cavitation in the contralateral or untreated lung. The earliest conversion takes place in cases with unilateral cavitation and no limiting adhesions. Concentrated sputum study should be made and, during reexpansion, guinea-pig inoculation, to confirm the absence of bacilli. It is only in retrospect from this point of sputum conversion that the length of the collapse period can be properly dated.

Regular fluoroscopic visualization of the lung during inspiratory and expiratory movement is essential to the conduct of pneumothorax for determining the degree of collapse, detection of extension of the process, adhesions, complicating pleural effusions, and mediastinal displacement. *Serial roentgenograms* at three month intervals should reveal evidence of progressive resolution, organization and fibrosis, probably with calcium deposits in successful cases.

Blood sedimentation rate determination is a valuable laboratory aid to management of pneumothorax when correlated with serial blood counts and bacteriology findings, as a good indicator of cessation of pathological activity of the tuberculous process under compression. The rate of settling of red blood corpuscles parallels the degree of activity of the disease focus.

By the ratio of lymphocytes to monocytes in the differential count, and shift to the left of the Schilling polymorphonuclear index, we have an additional and perhaps more delicate measure for evaluating the activity of the tuberculous process and that indefinable something of prognostic importance which we call resistance.

#### ACCIDENTS AND COMPLICATIONS OF PNEUMOTHORAX

*Gas embolus*, carried from pulmonary veins to coronary or cerebral arteries, occurs about once in every 500 or 1000 pneumothorax treatments. Most frequently it occurs at the induction of pneumothorax. It may be prevented by making sure the needle tip is in the pleural cavity before administering air. Manometric oscillations must show a negative pressure sufficiently great to indicate that the needle is in the pleural cavity and not in a pulmonary vessel. Air introduced into the pleural cavity may be sucked into pulmonary vessels when rupture of an adhesion at its pulmonary attachment exposes the open vessels to intrapleural air. This complication has been reported as proving fatal in as many as 50 per cent of the cases.

*Pleural shock*, a syndrome due to irritation or puncture of the pleura may be difficult to differentiate from air embolism, which it resembles clinically, but is usually not fatal.

*Spontaneous or accidental pneumothorax* may result from the needle penetrating the lung, allowing the air from the lung to leak into the pleural cavity. More commonly an adhesion may rupture at its pulmonary attachment producing a bronchopleural

fistula. A further cause may be extension of a subpleural focus burrowing into the pleural cavity. When a flap of visceral pleura acting as a check-valve at the fistulous opening prevents return of air from the pleural cavity to the bronchial tree, air may have to be aspirated to prevent death.

*Mediastinal shifting and herniation* may produce embarrassment of respirocirculatory nature. A weak or flexible mediastinum results in delayed rise in manometric readings with little difference in inspiration and expiration. A rigid mediastinum produces opposite effects. A mobile mediastinum may be stabilized by shortening the refill intervals and varying the amounts of air administered. At times it is necessary to stiffen the mediastinum by injection of sterile olive oil or mineral oil into the pleural cavity. Occasionally *subcutaneous emphysema* results from leaking of air directly following treatment into the tissues. The patient should be reassured it is of no significance.

During the first day following induction of pneumothorax the patient may experience a sensation of heaviness in the chest with discomfort, aching or pain. This is due to stretching of adhesions in most cases and may be controlled readily with codeine.

*Pleural effusion* occurs in 30 to 70 per cent or more of cases of pneumothorax. About 10 per cent of these fluids become purulent and contain tubercle bacilli. *Empyema* is most serious when it is due to mixed infections and associated with a bronchopleural or subcutaneous fistula. Of little significance is the small serous effusion which consists of fluid normally present lubricating the pleural surface. During pneumothorax this fluid gravitates to the costophrenic sinuses and may be found by careful search in almost every case. Less frequently, large serous effusions occur of low cellular, protein and fibrin content. Its formation is heralded by low grade fever and mild toxemia for several days.

Such effusions usually develop during the first three to six months of treatment

which represents the period in which the collapse is still recent and incomplete and the lung most accessible to the effects of sudden or too excessive pressure fluctuations.<sup>5</sup> Incomplete pneumothorax because of adhesions favors the formation of effusion. Too sudden pulmonary compression and too sudden and excessive fluctuations of pleural pressure are to be avoided as this upsets the normal correlation between ventilation and circulation in the lung. If not aspirated, fluid may remain for weeks or months. When aspiration it is carried out to relieve pressure symptoms, at times more active pleural absorption is apparently stimulated.

By diminishing the size of the pleural space the presence of pleural effusion results in abnormally high initial pressures or an abnormally high rise in pressure soon after air is administered during refill. If there is much fluid depressing the diaphragm, respiratory excursions may be absent or paradoxical diaphragmatic movement may occur.

Long standing pleural effusions favor the formation of *obliterative adhesions* with resulting loss of pneumothorax space. Perhaps one-third of pneumothoraces are abandoned in three months time for this reason. To prevent this complication frequently *oleothorax* is given.

Fibrotic and fibrinous changes resulting in eventual pachypleuritis are more promptly manifested if exudation has occurred.

In the presence of pleural adhesions restricting the pleural space, the rise of pleural pressure is accelerated on the administration of air. When adhesions are deemed severable, intrapleural pneumolysis as an adjunctive measure results in a more complete collapse of lung in 60 per cent of cases.

<sup>5</sup> MAYER, E. and DWORKIN, M. Nature of pleural effusions complicating artificial pneumothorax. Read at the Symposium of the Metropolitan Sanatorium Conference, N. Y. Tuberculosis and Health Association, Oct. 7, 1936. To be published.

#### CRITERIA FOR TERMINATION OF PNEUMOTHORAX

The condition of the lung before collapse with regard to the extent and particularly the type of the original lesion, is one of the most important points in determining re-expansion. Old x-ray films prior to institution of treatment should be reviewed. If extensive ulcerocaseous disease with large cavity formation and marked constitutional disturbances existed, the pneumothorax should be continued for more than three years, in some cases six to seven years, if relapse would be avoided. Cavities collapsed and with negative sputum for more than two years are quite free from the danger of reactivation on reexpansion of the lung. Eighty per cent of the patients with closed cavities and who are symptom-free and with a negative sputum, as a result of satisfactory collapse of the lung, regain complete working capacity; those with uncollapsed cavities and positive sputum rarely make an economic recovery.<sup>6</sup> More favorable for reexpansion are lesions which under pneumothorax show changes of resolution roentgenologically, stellar fibrosis and calcification of foci. Exudative lesions may heal completely, leaving no scar. Where there was considerable original lung destruction, a phrenicectomy or partial thoracoplasty may be necessary to completely obliterate the pleural cavity. More confidence is felt in considering reexpansion in cases in whom there was conversion of positive to negative sputum, with signs of rapid cessation of pathological activity within three to six months after induction of the treatment. In younger patients even with an exudative lesion between the ages of fifteen to thirty years, reexpansion should not be permitted within three years. This is likewise a consideration with patients of poor means, especially if they must return to hard labor, or unsanitary surroundings with poor food and lack of fresh air.

<sup>6</sup> MAYER, E. Cavity in the tuberculous, its management. *J. A. M. A.*, 100: 1478 (May 13) 1933.

In reexpanding the lung, it is a good plan to maintain a 10 to 20 per cent degree of collapse for four to six months so that during this period the lung may be given a trial of reexpansion under conditions approximating normal activity and exercise. If the roentgenogram shows no change under this altered regime and the sputum remains negative on concentration and guinea-pig inoculation test, refills may be discontinued and the pleural space allowed to obliterate.

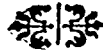
#### SUMMARY

Practical aspects of artificial pneumothorax as applied to the treatment of

pulmonary tuberculosis are briefly presented for office and bedside use.

Indications for the institution of treatment are fairly clear cut. The physiologic dynamics of pulmonary compression, technical details of the operation, criteria of management and termination of collapse therapy are briefly outlined.

Included also is a discussion of accidents and complications of treatment and their management, as well as indications for adjunctive measures for securing adequate collapse as pneumocautery, phrenicoexeresis and thoracoplasty.





# USEFUL ARTIFICIAL FEEDING FORMULA

GURN STOUT, M.D.

LOS ANGELES

QUITE frequently in the practice of medicine one encounters patients who present a problem which arises from many and diverse causes, as to how to meet their nutritional needs. Some patients are unable to eat due to a continuous semistuporous or comatose state resulting from conditions such as head injuries, brain tumors and abscesses, infections of the meninges, etc. Malignant tumors and occasionally ulcers in the upper gastrointestinal tract produce partial obstructions which render the retention of food difficult.

Patients may be strongly disinclined to take food due to an overpowering anorexia. This situation frequently obtains in post-operative drainage cases, especially if a malodorous one. Anorexia is common in the various types of enterostomies and in generalized peritonitis.

The taking of ordinary food in sufficient quantities when ileus (functional or paralytic) is present, quite commonly aggravates the condition and distresses the patient by increasing the tympanites.

When confronted with such a feeding problem we have used an "artificial" food formula since 1929. This was first brought to general attention when it was briefly mentioned in a paper<sup>1</sup> published in 1931. This formula is liquid and is administered through an indwelling Levin tube passed transnasally to the stomach or duodenum. The material is freshly prepared when needed, in amounts of one liter. The individual dose is measured and warmed to the temperature of "baby's milk" and instilled through the duodenal tube every two hours, day and night. Between feedings the "food" is kept in the refrigerator.

<sup>1</sup> STOUT, GURN. Gastrointestinal obstruction, functional and organic. *Ann. Surg.*, 94: 347-353 (Sept.) 1931.

On the first day the dose usually given is 20 c.c., this being increased by about the same amount daily until the patient's caloric needs are met.

The formula has a high caloric value, approximating two calories per cubic centimeter. If the amount given is increased too rapidly, nausea and sometimes vomiting result. This reaction seems to be equivalent to overfeeding the patient with regular food too early in his convalescence. It is only necessary to reduce the amount temporarily when this occurs.

We have in this manner been able to maintain patients in excellent nutritional condition over periods of eight weeks or so. Over such extended periods it is of course necessary to remove the Levin tube intermittently (every four to seven days) for a few hours in order to clean it and to rest the throat.

Before passing the tube it has been our practice to spray the nose and throat with 0.5 per cent cocaine (alkaloid) in liquid petrolatum. The tube itself being lubricated with the following:

|   |                            |       |
|---|----------------------------|-------|
| R | Cocaine (alkaloid).....    | gr. 5 |
|   | Oxyquinoline Sulphate..... | gr. 1 |
|   | Pulvis Caroid.....         | gr. 5 |
|   | Petrolatum.....            | oz. 1 |

The first two ingredients are for the purpose of providing anesthesia and antisepsis respectively, and the last two, to reduce the amount of mucus accumulating on the tube.

When the tube is in position, the nose and throat should be frequently sprayed with such a preparation as mistol.

From the dietetic point of view the formula seems complete in all essential particulars, for the purpose intended. It has been modified and improved from time to time and its present composition is as follows:

|                                 | Grams |
|---------------------------------|-------|
| Sodium chloride.....            | 15.0  |
| Mead's Mineral Mixture No. 85.. | 4.0   |
| Glucose.....                    | 50.0  |
| Lactose.....                    | 100.0 |
| Dextrin.....                    | 100.0 |
| Peptone.....                    | 50.0  |
| Calcium caseinate.....          | 25.0  |
| Bouillon cubes, beef.....       | 2     |
| Cod-liver oil.....              | 15.0  |
| Olive oil.....                  | 15.0  |
| Egg yolks.....                  | 2     |
| Cream 40 per cent.....          | 100.0 |
| Yeast extract.....              | 2.0   |
| Cevitamic acid.....             | 0.2   |

It is prepared in the following manner:\* Measure out 500 c.c. of water and from this add a small amount to the first eight ingredients of the formula. At first use only sufficient water to make a thin paste, then gradually add the balance of the 500 c.c. Heat over a moderate flame guarded by an asbestos mat, until the mixture reaches a temperature of 44°C. (110°–112°F.). Stir constantly while heating and remove from the flame immediately this temperature is

\* Courtesy of the pharmacists of the Hollywood Clara Barton Memorial Hospital.

obtained, and guard against overheating. Add immediately, while still hot, the cod-liver oil and olive oil, mixing with an egg-beater. Allow to cool to room temperature and beat in the remaining ingredients. Lastly, water should be added, if necessary, to make one liter. The final preparation should be smooth and show no evidence of curdling.

#### SUMMARY

1. The problem of how to meet the patient's nutritional demands is often-times difficult.
2. Examples of such instances are mentioned.
3. The need for a satisfactory "artificial" food formula is frequently observed.
4. The composition of an "artificial" food formula that has proved clinically useful in the author's hands is given.
5. The method of preparing the formula is described in detail.
6. The manner in which the food is administered is outlined.



# OPERATING ROOM SIGNALS

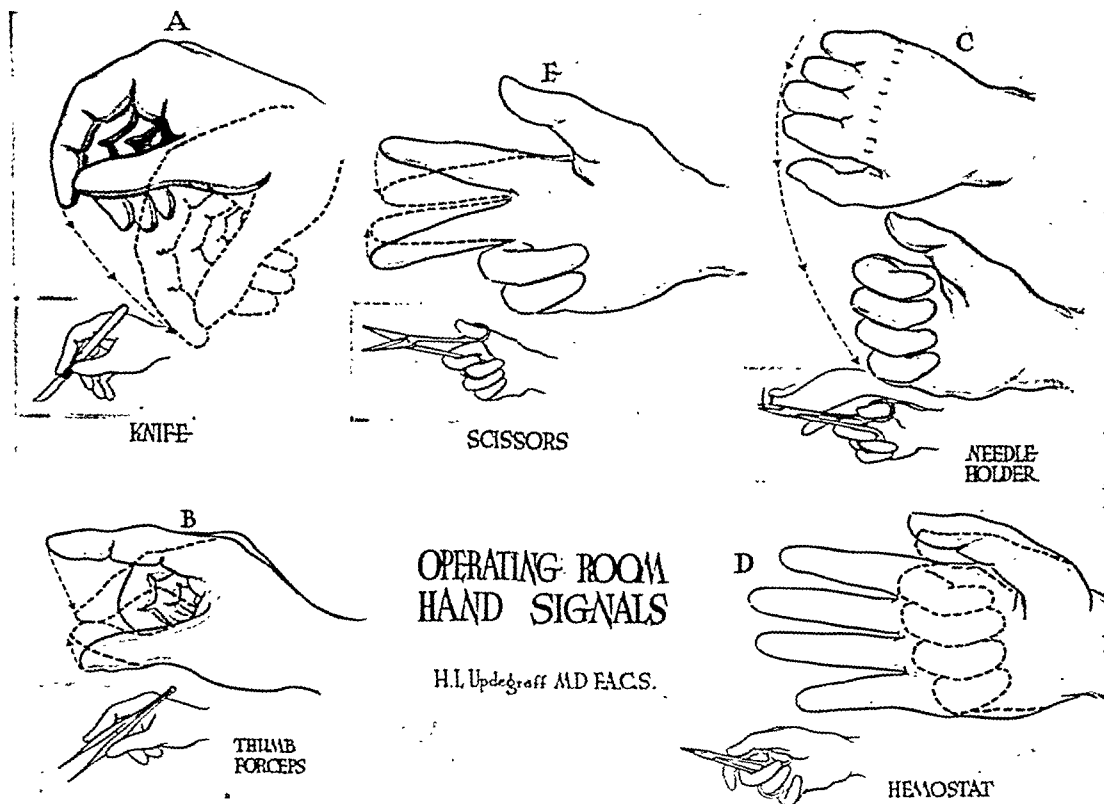
HOWARD L. UPDEGRAFF, M.D., F.A.C.S.

Director of Department of Plastic and Reconstructive Surgery, Cedars of Lebanon Hospital, Hollywood; Chief of Plastic Surgery Service, Orthopaedic Hospital, Los Angeles

HOLLYWOOD, CALIF.

**A** SURGEON once was about to begin an operation on a very famous and incidentally very wealthy pa-

screwed on tightly." Only the strap around the table kept the patient on it. After much reassurance and tedious injection of the



A, signal asking for a knife imitates with the hand the motion of making an incision; B, need of large or small thumb forceps may be designated by the amount of the opening between the thumb and first two fingers; C, needle holder is requested by making a rotating motion with the hand the same as that employed in using a large curved needle; D, crushing action of the hemostat is illustrated by opening and closing the hand like a hemostat had been placed in the palm; E, scissors are the easiest for which to signal as the first two fingers simulate the blades. All signals are immediately followed by holding the hand out for the instrument without removing the eyes from the operative field.

tient. Among other things the patient had requested, was a local anesthetic. After endless conferences, arrangements and preliminaries the morning for the surgery arrived and the patient placed on the table.

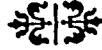
The surgeon said to his nurse, "Hand me the syringe and see that the needle is

local anesthetic, the surgeon said, "Now hand me the knife," and fifteen minutes later the patient left the surgeon's care forever—without having had the operation or paying any fee.

Practically all surgeons have had somewhat similar experiences. Many have learned to have their instruments arranged

on a nearby table so as to be accessible without asking for them or have managed to point for what they wanted, with fair success. After pointing for awhile, I found that by imitating the use of the instrument with my hand, that my assistants soon recognized the code and in turn signaled one another.

The illustrations are not presented as something new or original, as similar routines must have been inaugurated in many surgeries. They are offered as a basis for improved variations, in the hope of stimulating smoother technique in the use of local anesthesia, either in the office or hospital operating room.



# BOOK REVIEWS

**RECENT ADVANCES IN GENITO-URINARY SURGERY.** By Hamilton Bailey, F.R.C.S. (Eng.) and Norman M. Matheson, M.B., F.R.C.S., M.R.C.P. Price \$5. Pp. 513 with 89 illustrations. Philadelphia, P. Blakiston's Son & Co., Inc., 1936.

This handy book covers the more recent advances in genitourinary surgery. No specialty, during the past few years, has undergone such changes or made advances on a wide front. Today urology is near to being an exact science and in treating these conditions a correct diagnosis can be made in nearly every case.

Therefore this compact, well written book, amply illustrated, fulfills its purpose in placing before the reader recent innovations as they affect the commoner conditions encountered in urological practice.

References to the literature are included at the end of each chapter. The Index is unusually complete.

**THE THYROID. SURGERY; SYNDROMES; TREATMENT.** By E. P. Sloan, M.D. Edited by members of the Sloan Clinic. Springfield, Ill., Charles C. Thomas, 1936. Price \$10. postpaid.

The author organized The Sloan Clinic in 1917 and it has been said that its location has become one of the national centers in the thyroid field. We are told that at the end of 1934 over 20,000 cases of goiter had registered at the Clinic, and that operations had been performed upon 15,000 of these. From the nucleus of the physicians Dr. Sloan gathered about him, the American Association for the Study of Goiter was formed.

This work does not pretend to be encyclopedic in scope. The chapters cover General Anatomy and Physiology, Etiology, Prophylaxis, Pathology, Symptomatology, Diagnosis, Prognosis, Indications and Contraindications for Treatment, Non-surgical Treatment, Anesthesia, Surgical Anatomy, Instruments and Ligatures, Preoperative Treatment, Operative

Technique, Postoperative Management, Hypothyroidism, Parathyroid Glands, Thymus, Historical, Nomenclature and Classification.

There is a Bibliography which lists 254 titles and an Index of this Bibliography; also, an Index of Subjects, and an Index of Names. There are 99 illustrations.

An interesting book and recommended to the general practitioner as well as to the surgeon who does work in this field.

**UROLOGY.** By Edward L. Keyes, PH.D., F.A.C.S., F.R.C.S. (Hon. England) and Russell S. Ferguson, A.B., M.D. Sixth Edition. With 343 illustrations in the text, and 17 plates, 3 of which are in color. New York, D. Appleton-Century Co., 1936.

What can one say in praise of a book that is offered to us in a Sixth Edition? That alone stamps it with the hall-mark of being standard and removed from the average. This edition is offered with every chapter rewritten "to keep pace with modern diagnosis and therapy and in particular to record the changed conceptions of the character of disease; e.g., intravenous urography, prostatic resection, calculogenesis, tuberculosis, tumor, and irradiation therapy." Adhering to this scheme a few chapters in the previous edition have been suppressed, while others have been enlarged, and some added.

We are told the junior author has, indeed, "influenced the whole, while the comments on pathology, irradiation, endocrinology and tumors" are from his pen exclusively.

Dr. John W. Draper is responsible for the chapter on "Preoperative and Postoperative Care."

We must quote the concluding paragraph of the authors' Preface: "It will, we trust, not be held against us that Cheerfulness has occasionally crept in; Cheerfulness, child of Hope, half-sister of Despair."

That the work is authoritative is understood; that it is a piece of literature the reader will discover for himself.

# The American Journal of Surgery

is the leading independent surgical Journal. It publishes many papers read before the outstanding Surgical Societies, but it is not "the official organ" of any organization. Every manuscript is selected by the editors, as worthy of publication—nothing is published because "it was read at the meeting."

Copyright, 1937, by THE AMERICAN JOURNAL OF SURGERY, INC.

NEW SERIES, VOL. XXXVI

MAY, 1937

No. 2

## EDITORIAL BOARD

Editor:

THURSTON SCOTT WELTON

New York

|                      |                  |
|----------------------|------------------|
| D. C. Balfour        | Rochester, Minn. |
| Carl Beck            | Chicago          |
| George R. Brighton   | New York         |
| Meredith F. Campbell | New York         |
| James T. Case        | Chicago          |
| Isidore Cohn         | New Orleans      |
| Bradley L. Coley     | New York         |
| F. A. Collier        | Ann Arbor        |
| George W. Crile      | Cleveland        |
| E. C. Cutler         | Boston           |
| R. V. Day            | Los Angeles      |
| Charles A. Elsberg   | New York         |
| Herbert C. Fett      | Brooklyn         |
| C. R. G. Forrester   | Chicago          |
| H. Dawson Furniss    | New York         |
| J. H. Gibbon         | Philadelphia     |
| Emil Goetsch         | Brooklyn         |
| Charles A. Gordon    | Brooklyn         |
| Donald Guthrie       | Sayre, Pa.       |
| A. E. Hertler        | Kansas City      |
| Louis J. Hirschman   | Detroit          |
| James M. Hitzrot     | New York         |
| Frederick C. Holden  | New York         |
| Emile F. Holman      | San Francisco    |
| J. A. Hyams          | New York         |
| R. H. Jackson        | Madison          |
| John E. Jennings     | Brooklyn         |
| W. L. Keller         | Washington, D.C. |
| H. A. Kelly          | Baltimore        |
| T. J. Kirwin         | New York         |
| Arthur Krida         | New York         |
| A. V. S. Lambert     | New York         |
| Maurice Lenz         | New York         |
| H. H. M. Lyle        | New York         |
| Jerome M. Lynch      | New York         |
| Urban Maes           | New Orleans      |
| Harrison S. Martland | Newark           |
| Rudolph Matas        | New Orleans      |
| Roy D. McClure       | Detroit          |
| H. C. Naffziger      | San Francisco    |
| C. R. O'Crowley      | Newark           |
| Louis E. Phaneuf     | Boston           |
| Eugene H. Pool       | New York         |
| Douglas Quick        | New York         |
| N. P. Rathbun        | Brooklyn         |
| H. A. Royster        | Raleigh          |
| Henry S. Ruth        | Philadelphia     |
| A. C. Scott          | Temple           |
| M. G. Seelig         | St. Louis        |
| J. Bentley Squier    | New York         |
| H. J. Stander        | New York         |
| George W. Swift      | Seattle          |
| H. L. Updegraff      | Los Angeles      |
| Grant E. Ward        | Baltimore        |
| J. H. Woolsey        | San Francisco    |

## EDITORIALS

### A NEW DEPARTMENT

DURING the past nine years, ever since we have edited The American Journal of Surgery, we have received, read and answered hundreds of letters from subscribers and readers of the Journal. Many of these letters were from physicians located in various parts of our country, Canada, Mexico, Porto Rico, Cuba and South American countries, describing the symptoms, and physical and laboratory findings of a case, and either asking us to make a diagnosis or appealing to us to outline suitable treatment. It has been our custom to send these inquiries to those whom we thought especially fitted and equipped to answer the questions asked.

Feeling there are many of our subscribers who at times wish information regarding the many aspects of a surgical problem, or who wish to be informed regarding certain drugs, procedures, technique, tests and the literature on and about a topic—surgery in its widest sense—we plan to inaugurate a department in the Journal to handle such matters. Beginning with the July or August number we will publish several of these letters and the answers sent the writers, and this department will be continued each month.

This service *must be limited to our subscribers*, who are urged to enclose a self-addressed, stamped envelope with each letter. They will be answered in the quickest possible time. A subscriber may write as often as he wishes and ask as many questions as he desires.

We feel that this service will prove of inestimable value to our subscribers, and we sincerely hope they will take immediate advantage of it.

T. S. W.

## MATERNAL MORTALITY AND OBSTETRIC CONSCIENCE\*

THE maternal death rate is a cause of grave concern. It is clear however, that modern limitation of the size of families with growing legions of abortions, relative increase in the number of primiparae with their higher incidence of difficult deliveries, and the growing age of primiparity itself, seriously affect comparison with older figures. Death certificates too, have been subjected to closer scrutiny, the New York survey alone indicating a total error of nearly 18 per cent. It is probable that improvement in the death rate, though not apparent, is none the less real.

Failure of statistics to yield to medical papers and discussion, revision of the undergraduate curriculum, certification of specialists, increased numbers of hospital beds, governmental investigations and popular education and movements is a mystery to some of us. Yet obviously all these have not been enough if statistics are accepted at their face value.

So long as obstetrics is an art, it will never be possible to teach more than obstetrical catechism in the medical schools; there is neither opportunity nor time enough to teach that which must be learned by practice, not precept. The young graduate is far better trained than his predecessors, yet we are still waiting for tangible results.

Statistical analyses are but a means to an end, and international comparisons are particularly futile. We are apt to lose sight of that. Of themselves statistics accomplish nothing, merely pointing out the avoidable coefficients of maternal mortality. It is a fact that all studies show that approximately one-half of the maternal deaths are preventable, yet even these findings are not conclusive. Though based on accurate information, interpretation of

human clinical data is not easy. The specialist's conscience, or the statistician's, highly developed and rigidly consistent, though aware of important social and economic trends may not give them true values when assigning deaths to preventable columns.

Education of the public is valuable and necessary, but time consuming and difficult. Told that complications are preventable, women expect none. They should be told that most of their hazards can be foreseen and controlled, but that pregnancy and labor are by no means safe undertakings. That is quite different. The time worn concept that childbirth is a physiological process should be summarily discarded as a harmful platitude. DeLee has insisted upon this for years. There will always be mortality, and it cannot be prevented by "protesting to your physician, to your mayor, to your governor, to your congressman, to your president." This interesting advice to the mothers of America appeared last March in a magazine with wide circulation among women in this country. The press can do us great service, but overemphasis on preventability will only hurt the good cause.

A very large proportion of maternal deaths is inevitable. It is not a simple problem; in fact it is a very complex and difficult one. Antepartum hemorrhage can not be prevented, nor will good management ensure safe delivery. Eclampsia may occur in spite of excellent supervision. Sepsis, the yardstick of intrapartum care, may follow spontaneous delivery, and does occur with increased incidence in operative deliveries where no other method of treatment was possible. The diagnosis of disproportion is not easy, and its management by induction, trial labor, difficult forceps or cesarean section involves alternative but

\* Read before the Brooklyn Gynecological Society, May 1, 1936.

no less considerable factors of risk. The less common presentations of the fetus and, more than anything else, posterior positions of the occiput increase maternal as well as fetal mortality.

No doubt the death rate is high. Certainly we are not satisfied. In the final analysis however, we are not concerned with percentages of preventability, or the recriminations which they invoke. If the mortality is unnecessarily high, and we believe it is, it can be reduced. Social and economic factors are involved, for surely the deaths from intentional abortion are beyond our control. Statisticians assign the mortality of criminal abortion to homicide; deaths from self-induced abortion are assigned to puerperal causes, but these too are largely criminal and not self-induced, though they may appear to be. Reduction of mortality is a social as well as a medical problem.

Prenatal care must be adequate, not perfunctory. In toxemia and hemorrhage its function is plain and well understood. Not so clear however are its implications in the all important matter of safe delivery, yet if it does not accomplish that, it is worth nothing.

We must remember that anesthesia, in itself a blessing, in a great many cases slows labor and increases the incidence of forceps deliveries. Interference, whether indicated or not, is the commonest cause of puerperal infection. Skill and judgment so necessary for any operative delivery other than low forceps, are no less requisite when we allow women to remain long in labor. Placenta previa and ablation of the placenta are formidable complications which tax the skill of the most expert, and eclampsia is no different. The outstanding feature of the Children's Bureau survey was that one-quarter of all the maternal deaths followed abortion; they were mostly due to sepsis, accounting for nearly half of all the deaths from puerperal septicemia, the greatest single cause of maternal mortality. That is important. When we are told that 19 per

cent of the deaths in New York City, 24 per cent in Boston, were due to cesarean section, we must listen. Cesarean is not for the novice or the casual obstetrician.

The hospital has very definite obligations in this matter of maternal welfare. Large or small it must closely supervise the obstetrics practiced within its walls, for responsibility for the patient does not rest entirely with the doctor. Not all hospitals are safe places for expectant mothers, and the small institution may be excellent, or it may be sadly inadequate, hardly deserving the name of hospital at all. Every hospital should be safe. This is not only what women rightfully expect, but the best interests of the institution, patient and doctor are served no other way. Facilities must be mobilized for advice and help, consultation must be easily obtained when indicated. Nothing must be left undone. The patient must be protected, the physician supported whether he wishes it or not. Then he will grow in knowledge and experience as he multiplies his contacts with the form and substance of good obstetrics. This is the best kind of postgraduate education.

Established moral values have broken down. Conscience asks if this is right, and the inner voice is always so clear that it is impossible to mistake it. Whether it is an intuitive or acquired facility of moral perception, conscience covers everything within a man that has to do with the decision and direction of his moral conduct. Every one of us worthy of our high tradition carries with him an accusing or a comforting witness. He only is content whose conscience is clear.

The obstetric conscience is acquired, and skill and judgment with it. It may be defined as a sense of obligation to obstetric principles. It never swerves from the basic principle of preservation of normal function. It never interferes unnecessarily, unwisely or without counting the cost. It stands firm against the importunity of sympathetic but unknowing relatives. It is proof against hurry and convenience.



It constantly weighs two lives in the balance of experience and knowledge. It crosses no frontiers without a responsible guide. It never forgets its plain duty. God help her who is so unfortunate as to place her trust in one who scoffs at conscience and God help him, too!

The experienced general practitioner, with an obstetric conscience, is the best practitioner of obstetrics. We need more obstetric physicians, less surgeons. We need hospitals keenly conscious of their responsibility to the public.

Nearly a hundred years ago (1842) Oliver Wendell Holmes, reading his "Essay on the Contagiousness of Puerperal Fever" before the Boston Society for Medical Improvement, spoke to the medical profession of the world:

The woman about to become a mother or with a newborn infant upon her bosom, should be the object of trembling care and sympathy wherever she bears her tender burden, or stretches her aching limbs. The very outcast of the streets has pity upon her sister in degradation, when the seal of promised maternity is impressed upon her. The remorseless vengeance of the law brought down upon its victims by a machinery as sure as destiny, is arrested in its fall at a word which reveals her transient claim for mercy. The solemn prayer of the liturgy singles out her sorrows from the multiplied trials of life, to plead for her in her hour of peril. God forbid that any member of the profession to which she trusts her life, doubly precious at that eventful period, should hazard it negligently, unadvisedly or selfishly.

Time changes. Conscience remains.

CHARLES A. GORDON.



Subscribers to THE AMERICAN JOURNAL OF SURGERY visiting New York City are invited to make the office of the publishers (The American Journal of Surgery, Inc., 49 West 45th Street, New York) their headquarters. Mail, packages or bundles may be addressed in our care. Hotel reservations will gladly be made for those advising us in advance; kindly notify us in detail as to requirements and prices.

# TOTAL THYROIDECTOMY IN ANGINA PECTORIS AND CONGESTIVE FAILURE\*

## THREE YEAR POSTOPERATIVE REVIEW OF 16 PATIENTS

MORRIS DINNERSTEIN, M.D.,

Associate Visiting Physician

I. OGDEN WOODRUFF, M.D.

Visiting Physician

CARNES WEEKS, M.D., F.A.C.S.,

Associate Visiting Surgeon

ALBERT R. TILLEY, M.D.

Research Resident in Medicine

Bellevue Hospital

NEW YORK

TODAY we are entering upon an era of surgical attacks on numerous diseases which have hitherto been treated along purely medical lines. These are chiefly incurable chronic ailments with a progressive tendency to fatality, or acute medical infections in which, despite medical treatment the mortality remains seriously high.

The surgical treatment of all of these diseases has had to go through stages of experimentation before finding justification and general acceptance. In some, the role of surgery is now on a firm foundation. In gastric and duodenal ulcer, apart from acute surgical complications, surgery, in selected cases, has its definite place; in tuberculosis, surgical procedures have completely revolutionized the treatment of that disease in the last few years.

In other diseases the value of surgery is still unproved, in the experimental stage and not generally accepted. In the acute group may be mentioned the treatment of acute lobar pneumonia by artificial pneumothorax, which is carried on in the hopes of reducing the high average mortality in this illness.

In the chronic group we may mention the operations of sympathectomy and of stripping the adrenal capsule in malignant hypertension and the total removal of the thyroid gland for the treatment of intractable cases of angina pectoris and congestive heart failure.

In view of the apparently favorable results reported by Blumgart, and by Cutler and their associates, we were led to hope that some of the symptoms might be alleviated in patients who had resisted medical treatment; and consequently three years ago we performed a thyroidectomy in a selected series of cases of congestive heart failure and angina pectoris. While only 16 patients have been under observation two years or more since operation, we are presenting our results for comparison with those already reported, in the hope of aiding in the determination of whether the surgical procedure is justified as a therapeutic measure in these two diseases.

### RATIONALE OF OPERATION

A brief historical sketch may be the most satisfactory means of approach to an understanding of the basic philosophy underlying the selection of total thyroidectomy as the surgical procedure considered suitable in these cases.

As early as 1825 Parry commented on the close relationship between congestive heart failure and thyrotoxicosis. He noticed the frequency of the onset of congestive failure or angina pectoris, either coincident with or following the appearance of exophthalmic goitre, and he also observed a subsidence of the signs of congestive heart failure following a decrease in the enlargement of the thyroid gland.

\* From the First Medical and Surgical (Columbia University) Divisions, Bellevue Hospital. Presented in part before the Section of Medicine, New York Academy of Medicine, March, 1936.

In 1902 Kocher's son reporting his father's cases, clearly demonstrated the improvement in congestive heart failure following subtotal removal of hyperactive thyroid gland. These observations have been repeatedly confirmed by other clinicians. Although at present there is some difference of opinion as to the etiological influence of thyrotoxicosis per se in the production of congestive heart failure, it is well known that when thyrotoxicosis occurs coincidentally with congestive failure there is a very marked clinical improvement in the cardiac status following subtotal thyroidectomy.

As regards angina pectoris, Francois Franck, as early as 1899 put forward the suggestion that the cervical sympathetic chain might contain afferent fibres from the heart, and also suggested that the pain of angina pectoris might be relieved by surgical interference with this system. However, it was not until 1916 that Jonnesco performed the first operation, removing the three cervical and the first dorsal sympathetic ganglia on both sides. In his first case the result was excellent, but the technical difficulties involved, militated against the wide employment of this operation. Later follow-up studies in a series of 66 cases showed that only 53 per cent have enjoyed a satisfactory result. Coffey and Brown of San Francisco in 1923 claimed good results merely by the removal of the superior cervical ganglia, or the division of its main branch. But later in a larger series of cases this showed only 48.5 per cent of satisfactory results. Other methods suggested and carried out for the relief of pain in this condition have included removal of the thoracic ganglia by a posterior approach, with paravertebral alcohol or novocaine injections of the rami communicantes and cutting of the depressor branch of the vagus.

An explanation of these variable and unsatisfactory results probably lies in the newer conception of the cardiac innervation as stated by Heinbecker:

Pain fibres from the human heart and the first portion of the aorta are found in all sympathetic nerve trunks supplying efferent fibres to these structures. These fibres enter the central nervous system via the fifth cranial nerve, via the rami communicantes, and by the dorsal roots of the 8th cervical and upper 6th and 7th thoracic nerves . . . The complete removal of the cervical sympathetic chain or the alcohol injection of the nerve roots from the 8th cervical to the 7th thoracic levels will not in themselves eliminate all pain pathways.

In 1927 Blumgart observed that the velocity of the blood flow was directly determined by the metabolic rate, the higher the rate, the greater the velocity. He also observed that in individuals with congestive heart failure, although the metabolic rate was normal, there was a compensatory lowering of the blood velocity which increased when these patients began to exhibit clinical improvement.

With these facts known, it was felt that circulatory deficiency depended somewhat on a deficiency of the blood supply for the metabolic needs, and that congestive heart failure occurred only when the metabolic needs were not adequately met. Therefore, it seemed reasonable that if metabolic demands could be lowered to a level that could be supplied by the damaged heart, then the signs and symptoms of failure should disappear.

Consequently, Blumgart, Levine and Berlin of Boston began to treat patients with congestive failure by complete extirpation of the normal thyroid gland. Subtotal thyroidectomy was performed on the first 2 cases with a marked temporary improvement, but when the remaining gland tissues began to regenerate and the metabolic rate rose, there was a recurrence of the original symptoms of failure. As a result of these experiences they then decided in 1932 to perform total thyroidectomies to see if a state of myxedema, which could be regulated by thyroid extract, would permit maintenance of the improvement over a longer period of time. Total ablation of the gland was

deemed essential as any vestige of thyroid tissue would regenerate and vitiate the benefit of the operation.

They also felt that total thyroidectomy might be of benefit in angina pectoris, as they believed that the considerations already stated regarding congestive failure, might be equally applicable to angina pectoris. To quote from them,

The higher the metabolic rate the greater are the output of the heart and the velocity of the blood flow. The consequent increased work of the heart necessitates an increased coronary blood supply. Because of these considerations and because the intrinsic needs of the myocardium rise along with those of the rest of the body, the blood supply to the heart must be greater at normal metabolic rates than at the lower rate of myxedema. With arteriosclerotic narrowing of the coronary vessels the blood supply to the heart through these vessels may be inadequate to the needs of a normal metabolic rate, although sufficient for the needs of the heart at a lower metabolic rate.

The foregoing theories as to the effect of total thyroidectomy were the basis of the original work in this new field of therapy. It was the favorable results reported by Blumgart, Levine and their associates which led us to do this work at Bellevue Hospital, where there are an exceedingly large number of cardiac patients with the usual proportion of those with congestive heart failure who are never long compensated, except when hospitalized.

Since the original work of Blumgart and his associates, several unexpected findings have arisen which are not adequately explained by the original theories. Illustrative of this is that immediately following the operation both groups of patients experience marked relief. The anginal patients are often free from pain and the congestive failure patients are relieved of palpitation and heart consciousness, and not infrequently, a rapid disappearance of liver enlargement occurs. These effects have been obtained in the majority of cases, but the basal metabolic rate has not fallen significantly for at least three

weeks and not usually below minus 20 per cent for three or four weeks following the operation. This has necessitated bringing in some new factors to account for the rapid immediate improvement. Several have been suggested, but none of them wholly adequate.

There is some evidence that clinical improvement in cardiac decompensation is not entirely dependent upon volume output of the heart. In other words, improvement in back pressure is not definitely related to any change in the cardiac output.

There is also some clinical and experimental evidence which tends to show that there is a fundamental difference in the response of the heart to injected or secreted adrenalin after total thyroidectomy. Minimal amounts of adrenalin injected subcutaneously before the operation produced anginal pain; double or triple these amounts postoperatively failed to produce pain. It is known that myxedema lowers the sensitivity to adrenalin, but there are almost normal quantities of the thyroid principle in the circulation for at least a week postoperatively. Therefore, unless one considers the action of some unknown hormone (as Cutler suggested at one time) the explanation of this early lowered response to adrenalin is not clear.

There is a further suggestion that the adrenals and their secretion are implicated by the studies in skin temperature of the extremities. In a series of 13 patients reported by Cutler and Schnitker, they found there was a definite increase in vasodilatation, comparable to that achieved by various operations on the sympathetic apparatus.

Blumgart and his co-workers believe that the immediate postoperative relief of anginal pain is due to the interference of the sympathetic nerve supply during the operation itself, as the thyroid is richly supplied with sympathetic nerve fibres and that this particular early beneficial effect is only temporary. However, the proportion of patients with early relief of pain following total thyroidectomy with

its relatively small interferences with the sympathetic nervous system, is large, if not larger, than the percentage of relief obtained with the much wider interference with the operation of cervicothoracic sympathectomy.

Horgan and Lyon reported favorable results of angina pectoris and congestive failure in a few patients in whom they limited their operation to ligating and cutting the superior and inferior thyroid arteries on both sides. The series reported was obviously too small to draw final conclusions, but it was of interest.

At the present time, though 2 cases with severe anginal pain had this operation done in our clinic with no relief of pain, it is impossible to arrive at an all-inclusive explanation of the benefit obtained by total thyroidectomy, but it would appear that at least three factors are of importance: (1) the lowering of the basal metabolic rate, (2) the interference with the sympathetic nervous system and (3) the change in the response to adrenalin.

Our study is based upon the postoperative review of 16 cardiac patients subjected to total thyroidectomy, 6 of whom suffered from severe angina pectoris, presumably due to coronary sclerosis, and 10 from cardiac decompensation, secondary to rheumatic, arteriosclerotic or syphilitic heart disease.

The series is comparatively small, from a statistical point of view, and the maximum period of observation only three years, with the most recent cases in the series operated upon two years ago. Nevertheless our results added to those of others have led us to believe that in carefully selected cardiac patients who do not respond to all available medical measures, the removal of the entire thyroid gland may prove to be a valuable therapeutic procedure.

None of the patients in our series showed any clinical signs or symptoms of hyperthyroidism and the operative basal metabolic rates were within normal limits in all except one. In this instance the preopera-

tive basal metabolic rate was plus 46 per cent and plus 25 per cent. The patient however, showed no clinical evidence of thyrotoxicosis and the excised thyroid gland, as well as those of all the other patients in the series, proved to be grossly and microscopically normal. In one patient, the preoperative basal metabolic rate was minus 14 per cent.

Our follow-up study was directed with several objects in view: (1) the attempt to evaluate the procedure as a therapeutic measure in severe intractable heart disease; (2) to afford the patients such medical therapy for their cardiac condition as might be necessary following the operation, since the operation per se has no apparent effect upon the underlying pathological process in the heart itself and (3) to endeavor to recognize, observe and treat any sequels or complications that might ensue from the operation itself. The patients were observed at frequent intervals following their discharge from the hospital to the cardiac clinic. Our follow-up included complete histories, physical examinations, frequent teleroentgenograms and electrocardiograms. At frequent intervals, estimations of the circulation time by the sodium cyanide method, and venous pressure determination by the direct venipuncture method were made. Our study also included basal metabolism rates and blood chemistry determinations at frequent intervals, the latter including calcium, cholesterol and non-protein nitrogen.

#### SELECTION OF PATIENTS

A large number of cardiac patients from the wards and cardiac clinic of the First Medical Division at Bellevue Hospital were studied with this therapeutic procedure in mind, but only a relatively small group selected. In an attempt to obtain a satisfactory clinical appraisal of this procedure, we felt at the outset that it was essential to select only those patients in whom it might be possible for us to analyze critically the results following operation.

In the anginal group, only those patients were selected in whom the attacks of severe precordial pain occurred quite regularly after a definite amount of exertion; all of our patients had in addition heart pain on rest (decubitus angina) and the seizures were so painful that they interfered with such ordinary activities as walking one city block or less and necessitated frequent doses of nitroglycerine or amyl nitrate. Those patients were excluded in whom the attacks occurred at irregular intervals, or in whom the serial electrocardiographic examination demonstrated progressive coronary artery disease. Four patients with angina pectoris had suffered from one or more attacks of coronary closure and showed electrocardiographic evidence of myocardial degeneration associated with coronary sclerosis. We avoided advising operation upon patients who suffered from a recent attack of coronary thrombosis, i.e., a closure that occurred within four to six months prior to operation. The duration of the anginal attacks averaged about two years with the exception of one patient who suffered for eight years. We also excluded a large group of introspective anginal patients in whom there were superimposed confusing nervous or neurotic symptoms because of the difficulty we might encounter in evaluating results in this type of patient, since the estimation of any postoperative improvement in the anginal group is entirely subjective.

In the group of patients suffering from cardiac decompensation, greater difficulties were encountered in establishing satisfactory criteria for the proper selections of patients for operation. Because of the marked variability in the clinical course of patients suffering from cardiac decompensation, we felt at the outset that only those patients with congestive failure should be selected for operation who had been observed and treated for a long period prior to operation. Most of the patients in this group had had repeated admissions and had been observed for a period ranging

from nine months to six years. A careful clinical study of the frequency and severity of the episodes of cardiac decompensation prior to operation was compared with a review of similar bouts of congestive failure following operation.

In the group with congestive heart failure, during the earlier period of the work, the operation was performed during a period of advanced decompensation. Later, the operation was advised only when the signs and symptoms of congestive failure had improved or disappeared with rest in bed, digitalis, diuretics and other measures directed toward the treatment of congestive heart failure.

It is necessary to note, however, that two of our most striking results in this group occurred in patients who were operated during a period of advanced congestive failure.

It seemed very likely as observed by others that the most satisfactory patients in the congestive failure group would be those who exhibited a slowly progressive clinical course or in whom the status was relatively stationary. We have felt it was best to limit this therapeutic procedure to that group of patients which gave a history of repeated periods of decompensation upon discharge from the hospital, but who would regain compensation when hospitalized and under treatment; showing they still had some reserve cardiac power. In other words, patients who give histories of rapidly progressive heart disease are considered unsuitable for total thyroidectomy. This is well exemplified by one of the patients operated upon early in this study (Case IV).

In the group with valvular disease one of our chief difficulties has been to exclude those patients with active pathological processes in the heart. Because of the very close casual relationship between active rheumatic infection in the heart and cardiac decompensation it was felt it was essential to eliminate those patients who exhibited clinical or laboratory evidence of active rheumatic process, such as

low grade fever or persistently elevated sedimentation rate. It is quite obvious that if such patients were selected any improvement that might occur after total thyroidectomy might well be attributed to the abatement of active rheumatic infection in the heart rather than the result of the operation itself. We therefore attempted to select those patients with recurring circulatory failure with no evidence of any active inflammatory process and in whom we felt the lesions were stationary, yet who in spite of all known medical measures were somewhat alleviated but nevertheless remained chronically incapacitated.

We have in general excluded patients suffering from syphilitic heart disease (aortitis, aneurysm, aortic insufficiency), because of the well established tendency in such patients, once congestive failure has occurred, to run a progressively down hill course. We have had but one experience in this series with a patient suffering from syphilitic aortic insufficiency; the improvement thus far in this particular patient has not been striking.

#### OPERATIVE PROCEDURE

At the suggestion of one of us (C. W.), all of our patients have been operated upon under cervical block anesthesia. General anesthesia has been avoided and the immediate postoperative course has been remarkably uneventful. A cervical block anesthetic following Labat's technique has been used most satisfactorily in all of our cases. Approximately 100 c.c. of 1 per cent novocain solution with five drops of adrenalin are used. Five cubic centimeters of this solution are injected over the transverse process of the second, third and fourth cervical vertebrae on both sides and approximately 15 c.c. are injected subcutaneously and subfascially just behind the sternomastoid in its mid-portion. This gives complete anesthesia which usually lasts for at least two hours. A search is always made for any aberrant thyroid tissue. Following the suggestion of

Berlin, the vocal cords are examined by the direct method after the first lobe of the thyroid has been removed without disturbing the operative field. This is done to make certain that there is one intact cord before proceeding with the operation.

In spite of the emotional strain of the operation only one of our patients suffered a severe anginal attack during the operation itself. Most of the patients, as is usual following any thyroid operation suffered from a mild tracheitis and difficulty in swallowing for about two or three days. No postoperative pulmonary complications developed in any of our patients. In 2 patients, symptoms of tetany, evidenced by numbness and tingling in the extremities, and positive Chvostek signs appeared during the first week following the operation. These symptoms were readily controlled by the administration of viosterol and large doses of calcium lactate. None showed any severe signs of tetany such as carpopedal spasm or convulsions and the mild symptoms noted did not recur after treatment and did not require continued calcium therapy.

We encountered only one instance of recurrent laryngeal paralysis, probably due to a collection of serum, and the symptoms were quite alarming; there were marked stridor, aphonia and respiratory embarrassment. Fortunately this proved to be transient and eighteen months following the operation there was no evidence of vocal cord paralysis.

We were interested in the problem of surgical myxedema and its sequels; we endeavored to learn if such a drastic procedure as complete removal of so important a structure as the normal thyroid gland might provoke such marked symptoms and signs of thyroid deficiency, that the clinical picture of myxedema might prove to be more serious and more distressing than angina or congestive failure. Would these patients develop profound structural and functional dis-

turbances such as myxedema heart, severe anemia and other changes that have been generally attributed, directly or indirectly to decrease or loss of thyroid activity? The duration of the elapsed postoperative interval, namely three years, is obviously too short to reach any final conclusion and it is quite possible that the early administration of thyroid extract may have proved effective in warding off such changes.

In reviewing the postoperative roentgenograms of the heart and electrocardiograms of these patients, thus far no noteworthy changes have been detected. There has been no appreciable variation in the size of the cardiac silhouette, except in 2 patients with congestive failure where there has been a diminution in the transverse cardiac diameter (at least over 1 cm.) this decrease in size having occurred as the signs and symptoms of cardiac decompensation disappeared. In the anginal group we have observed no increase in the size of the heart shadow. In none of the patients have we seen any of the electrocardiographic changes that have been attributed to so-called myxedematous changes in the heart muscle, such as low voltage of all the complexes, inversion of the T waves and increased auricular-ventricular conduction time.

One or more of these variations have been noted in some of our patients but they were present prior to the operation. It is not improbable that the changes that are frequently attributed to the so-called myxedema heart will occur only when the disease is of long duration, as is the case in spontaneous myxedema, and that these abnormalities have been thus far warded off by the early feeding of thyroid extract following operation. Only one patient operated upon three years ago, has shown evidence of a moderately severe anemia.

#### SURGICAL MYXEDEMA

The symptoms and signs of surgical myxedema usually appeared within a period of four to eight weeks following the operation. These symptoms varied con-

siderably in degree in different patients and usually were insidious in their development, although occasionally, for some unexplained reason, would appear quite suddenly. The most striking symptoms we have observed were those chiefly pertaining to changes in the facial appearance of the patient, such as puffiness of the face, including the eyelids, yellowish pallor of the skin, heaviness of the legs, tiredness, weakness, drowsiness and slowness of speech. As a rule, these symptoms were never very distressing and responded readily to the administration of desiccated thyroid extract. Postoperatively, the basal metabolic rate usually began to drop about the second week, and without the administration of thyroid extract, fell to about minus 30 to minus 40 per cent at the end of five or six weeks.

It was interesting to note that not infrequently, the symptoms and signs of surgical myxedema did not run strictly parallel to the drop in the metabolic rate; in other words, we encountered patients with basal metabolic readings of minus 30 per cent to minus 40 per cent, who exhibited clinically very few manifestations of myxedema and, on the other hand, a large percentage of our patients in whom repeated basal metabolic readings would be within limits that we recognized as normal or slightly below normal, would show unmistakable clinical manifestations of myxedema. In the latter group, the examination of the blood cholesterol usually showed marked elevation above the recognized normal figures. The level of the cholesterol content of the blood appeared to be a more sensitive index of the myxedematous state than the determination of the basal metabolic rate.

The not infrequent absence of any correlation between the clinical phenomena of artificially induced myxedema and the basal metabolism determination has led us to confirm the observations others have made in spontaneous myxedema, namely that the elevated blood cholesterol often appeared to be a more reliable



indication of the degree of hypothyroid function than the drop in the metabolic rate.

#### ADMINISTRATION OF THYROID EXTRACT

As has been mentioned, the symptoms of artificially induced myxedema usually responded readily to substitution therapy. As a rule, thyroid extract (Armour's) in a small dose of  $\frac{1}{4}$  grain daily, was administered at the end of the fifth or sixth week when the basal metabolic rate approached between minus 30 to 40 per cent. We then prescribed desiccated thyroid in ascending doses to the highest point at which they could hold their clinical improvement to the symptoms of thyroid insufficiency. Our experience has been very much like that of the Boston workers in that we found very small doses were required to treat surgical myxedema, unlike spontaneous myxedema in which much larger doses are usually necessary. Practically all of our patients required a daily administration of only  $\frac{1}{4}$  to  $\frac{1}{2}$  grain of the preparation of thyroid extract to relieve them of any signs or symptoms of myxedema.

In one patient we observed the effect of administering what was an excessive dose of thyroid extract. In this instance, thyroid extract had not been administered for a period of six months following the operation. At that time, because small doses of the thyroid extract afforded no relief of the very severe symptoms of myxedema which developed, the basal metabolic rate having dropped to unusually low levels, (minus 71 per cent and minus 75 per cent) we prescribed 5 grains of thyroid extract daily; after three days, the basal metabolic rate rose to plus 16 per cent and severe anginal pain appeared. When the dosage was reduced, this disappeared and the patient has since remained free from precordial pain upon the lower level of thyroid extract administration.

We have one patient in our series who up to very recently has not required the administration of thyroid extract. The

operation was performed three years ago. Although his basal metabolic, two months following the operation had fallen to the level of minus 38 per cent and minus 44 per cent, the patient showed practically no clinical manifestations of myxedema and the signs and symptoms of congestive failure had disappeared in a most striking way. For some unexplained reason, three months following the operation the basal metabolic rate gradually rose to minus 16 per cent, minus 9 per cent and plus 3 per cent, and remained within these normal limits up to nine months following the operation without the administration of any thyroid extract, the blood cholesterol also remaining at a fairly normal level, 210 mg. per 100 c.c. It was thought that possibly some fragments of the thyroid gland had been left at the time of operation or that some aberrant thyroid tissue was present, but, all during this period the striking clinical improvement persisted and the patient remained free from any signs of congestive failure and was engaged in normal activity.

Curiously enough, eleven months following the operation, his basal metabolic rate began to drop again somewhat to the level of minus 16 per cent and the blood cholesterol rose to 340 and he began to show definite clinical evidence of myxedema for which he required thyroid extract.

It may be of some interest to record the present postoperative status of the basal metabolism and blood cholesterol levels of our successfully treated patients, following the administration of a daily ration of thyroid extract. In the congestive failure group the present basal metabolic readings average minus 14 per cent with the blood cholesterol levels averaging 356 mg. per 100 c.c. In the group with angina pectoris, the readings average minus 16 per cent with cholesterol readings averaging 310 mg. per 100 c.c. It may be of interest to note, this being especially true of our anginal group, although the blood cholesterol figures remain elevated, the basal metabolic rates are not strikingly lowered; only

moderately less than the preoperative metabolic rates. In other words, striking clinical improvement with relief of anginal pain has persisted even though the basal metabolic rate gradually rose to what amounted to practically preoperative level, following the feeding of thyroid extract.

#### POSTOPERATIVE RESPONSE TO DIGITALIS

In the congestive failure group, we observed an interesting difference to the response to digitalis therapy following operation. The adequate dosage of digitalis in patients with auricular fibrillation appeared to be less than that which was required prior to operation. It is doubtful if this can be explained on the basis of clinical improvement following the operation, inasmuch as those patients when readmitted in congestive failure would require smaller doses of digitalis to reduce the heart rate than was observed previous to the operation. The reduced amount of the drug required may possibly be attributed to one or more of three factors: (1) an altered absorption to the drug from the gastrointestinal tract; (2) an altered elimination of the drug, in other words, the factor of cumulation; and (3) an increased sensitivity to digitalis following thyroidectomy due to increased tone of the vagus nerve induced as a consequence of the development of myxedema. Further observations and study are essential in the consideration of this matter.

#### POSTOPERATIVE WATER RETENTION

We would like also to call attention to another clinical observation noted in postoperative behaviour of our group of patients with congestive failure. When these patients were readmitted to the hospital in congestive failure following operation, they exhibited evidence of striking water retention; the severity of the edema was out of all proportion to the rest of the clinical picture of congestive failure and more pronounced than that which was observed during the attacks of decompensation prior to the operation. This appeared

especially true of accumulation of fluid in the serous cavities. Ascites or hydrothorax would not infrequently appear as initial manifestations of congestive failure. Thyroid extract in the small doses usually fed to those patients had no appreciable effect on the edema or the serous effusions but the mercurial diuretics seemed quite effective.

#### POSTOPERATIVE POLYNEURITIS

In this series, 2 patients presented a very unusual clinical picture of a severe type of peripheral polyneuritis, the etiology of which is still obscure. The onset of the symptoms in one patient was three months and in the other, six months after the operation. The symptoms were essentially severe pain in the hands and feet, coldness and weakness of the extremities, and other distressing parasthesias. In one patient, the deep reflexes, formerly hyperactive, disappeared, while in another, the deep reflexes were unaltered except for the Achilles tendon reflexes, which were not elicited. There was hyperesthesia to the touch of the point of a pin and light stroking of the skin over the area of the hands and feet; deep nerve tenderness was also present. The paresthesias were chiefly numbness and needle-like pain following the distribution of either the ulnar or median nerve. Bone conduction and the sense of position were unaffected. The administration of thyroid extract in small doses produced no relief of the symptoms. There were no signs suggestive of parathyroid deficiency, such as low blood calcium or positive Trousseau or Chvostek signs, nor was there any relief of the symptoms after the administration of viosterol or large doses of calcium. The blood picture revealed no significant abnormalities and a study of the gastric contents showed no changes except in one in whom an achylia was present. We have recently placed both of these patients on a high vitamin diet but the time elapsed since this regime has been instituted, has been too short to detect any improvement.

None of our other patients have shown a similar complication. It is possible that the cervical block anesthesia may be the causative factor of the parasthesia encountered in these 2 patients.

#### RESULTS OF OPERATION

Before reviewing our own results, it may be of interest to tabulate briefly the results of a statistical questionnaire submitted to twenty-six different clinics, where the operation of total ablation of thyroid gland has been performed for angina pectoris and congestive failure. The strikingly low operative mortality rate, 6.9 per cent, is of interest and this is of especial significance when one considers the very serious nature of the underlying pathological processes. Almost 80 per cent of the congestive failure group that survived the operation have apparently been benefited by the procedure, and a somewhat larger percentage in the anginal group have been either markedly or moderately improved.

Our own results are also briefly summarized below. There were 2 operative deaths, or 12.5 per cent, both in the congestive failure group. The first patient died from pulmonary edema twenty-four hours postoperatively; there was a co-existent bilateral nephrolithiasis and pyonephrosis and in view of our subsequent reference, should have been refused operation. The second patient was a hypertensive with congestive failure who suffered a cerebral hemorrhage toward the end of the operation, and died twenty-four hours later. There has been one later death in the angina group, or 6 per cent, not related to the operation, death occurring from a coronary closure ten weeks following the operation. No necropsies were obtained. Of the remaining 5 patients in the anginal group, 4 have been markedly improved, having remained practically free from precordial pain since operation. Occasionally after strenuous activity, especially in cold weather, slight pain will recur, but these attacks usually are not severe and do

not require the administration of nitroglycerin. One of these patients was a moderately severe diabetic, before operation carrying a persistently high blood sugar. On the fourth day postoperatively, the urine became sugar-free and although the diet has remained unchanged, the urine has remained sugar-free, although there has been no corresponding change in the blood level. One anginal patient, though greatly relieved of his attacks of precordial pain, has been incapacitated because of peripheral neuritis.

Of the remaining 8 patients of the congestive failure group, 3 have shown practically no improvement since operation. Two have continued with progressive decompensation, the other, suffering from syphilitic aortic insufficiency, has had repeated hospital admissions for a questionable congestive failure. The other 5 patients have received marked benefit from the operation, with no recurrence of episodes of decompensation, and return to normal activity has been achieved.

#### CASE REPORTS

CASE 1. J. H., forty-nine years of age, white male, janitor, has had symptoms of heart disease for the past twelve years. In 1926, he was first admitted to a hospital for congestive failure. From 1930 to January, 1934 he had 6 admissions to Bellevue Hospital because of severe decompensation. During the intervals he was observed in the cardiac clinic and was never completely free from symptoms.

He has had nocturnal dyspnea, exertional precordial distress, chronic cough and swelling of the abdomen, and edema of the ankles and legs in varying degrees for four years.

Physical examination revealed a thin white male with marked dyspnea and orthopnea, and slight cyanosis; large pulsating veins of the neck; rales in base of right lung and a left hydrothorax, which was tapped twice. There was a systolic retraction at the apex as well as of entire right chest. A diffuse precordial impulse, a presystolic thrill, and presystolic and systolic murmurs at the apex, and a diastolic murmur at the base were present. The apex was in the sixth space at the anterior axillary line. There was a slow auricular fibrillation. The

blood pressure was 116/90. The liver was four fingers breadth below the costal margin. Pitting edema of the ankles and legs was evident.

A teleroentgenogram showed cardiac enlargement in all diameters, with a marked accentuation of the left auricular and ventricular curves.

Electrocardiogram showed a slurred Q.R.S. complex, slow auricular fibrillation and a digitalis effect.

*Diagnosis:* Rheumatic heart disease; mitral stenosis; aortic insufficiency; auricular fibrillation; Class III.

The prognosis without operation was unquestionably poor. The intervals between hospital admissions were becoming shorter and his condition in the intervals was not good enough to enable him to carry on normally.

Total thyroidectomy was performed on February 9, 1934 under cervical block anesthesia. The postoperative course was uneventful. The patient was allowed out of bed on the ninth day. His general condition improved rapidly. Precordial distress and heart consciousness completely disappeared. Edema of the ankles completely disappeared with administration of digitalis and salyrgan. Ten weeks postoperatively he had a recurrence of congestive failure and was readmitted to the hospital where he improved rapidly with rest in bed, digitalis and salyrgan. There were no further readmissions until eighteen months postoperatively, when he was readmitted for a right hernioplasty in October, 1934. His postoperative course was uneventful. He has been followed in the cardiac clinic since that time.

The basal metabolism rates were as follows:

|                                    | Per Cent |
|------------------------------------|----------|
| 1 week prior to the operation..... | +11      |
| 1 week after.....                  | +17      |
| 3 weeks.....                       | -15      |
| 4 weeks.....                       | -25      |
| 7 weeks.....                       | -27      |
| 9 weeks.....                       | -42      |
| 14 weeks.....                      | -39      |
| 4 months.....                      | -27      |
| 5 months.....                      | -30      |
| 6 months.....                      | -24      |

At this point he was started on his thyroid feeding at a quarter of a grain a day; this was increased to a half a grain a day three weeks later, and has been continued at that amount up to the present. The basal metabolic rate two years postoperatively is -30 per cent.

At present, three years after total thyroidectomy, he is able to walk four blocks at a moderately rapid pace, without symptoms of distress and is able to go up one flight of stairs. He has not been readmitted to the hospital wards for over twenty-four months, a longer period of freedom from hospitalization than he had enjoyed for the preceding four years. He is free from palpitation and heart consciousness, and the other unpleasant symptoms of congestive failure.

CASE II. C. S., forty year old white male, a plumber, first noticed symptoms of heart disease and cardiac pain in May, 1933 and had admissions to Bellevue Hospital because of severe decompensation. The dyspnea was constant; he was not able to walk more than half a block; and he slept on four pillows. A severe precordial "ache" had been present for six months, which radiated down the outer side of both arms. These attacks would occur about every two or three weeks and would last for two or three days. Had noticed forceful irregular precordial palpitation for eight months. There had been edema of the ankles, legs and sacrum.

Physical examination on admission revealed a well preserved middle aged male, with marked dyspnea and orthopnea. There were moist rales at both bases and a left hydrothorax. The apex was in the sixth intercostal space at anterior axillary line;  $P_2$  was greater than  $A_2$ ; and a rumbling apical systolic and diastolic murmur were heard. Auricular fibrillation was present. His blood pressure was 130/96. The liver was five fingers breadth below the costal margin. Edema of the legs and ankles was also evident.

An electrocardiogram showed auricular fibrillation, with left ventricular premature contractions and myocardial changes.

*Diagnosis:* Chronic rheumatic heart disease; essential hypertension; mitral stenosis; auricular fibrillation, Class III.

The prognosis without operation was unquestionably poor. While there had been a moderate degree of compensation restored following his frequent periods of hospitalization, he had never been able to regain normal activity.

Total thyroidectomy was performed on February 9, 1934, under cervical block anesthesia, no supplementary anesthesia being required.

There has been no recurrence of symptoms of congestive heart failure.

The basal metabolic rates were as follows:

|                                    | Per Cent |
|------------------------------------|----------|
| 2 days prior to the operation..... | + 2      |
| 2 weeks after the operation.....   | - 8      |
| 5 weeks.....                       | -11      |
| 6 weeks.....                       | -23      |
| 7 weeks.....                       | -38      |
| 8 weeks.....                       | -44      |
| 10 weeks.....                      | -48      |
| 12 weeks.....                      | -16      |
| 14 weeks.....                      | - 9      |

At the eleventh month the rate dropped to minus 16 per cent, and he began to appear very myxedematous, and for the first time thyroid extract was administered,  $\frac{1}{4}$  grain being given daily.

The blood pressure has been very interesting; during the periods of severe decompensation before operation the blood pressure would fall as low as 128/84, rising with improvement of symptoms to 170/120 approximately; at the time of operation the blood pressure was 130/96. This rose gradually following the operation to 150/100; at the end of the first month, 175/100; at the end of three months, and from that time until the present (thirty-six months postoperatively) it has ranged between that figure and 218/125.

Twenty-nine months following operation, he was working, and there had been no recurrence of symptoms of congestive failure, despite the fact that he frequently overindulged in the use of alcohol, strongly against our advice. There had been no recurrence of attacks of paroxysmal auricular fibrillation.

The result in this particular patient had been very striking, as he had been enabled to return to active life and to carry on rather heavy physical labour.

In July, 1936 he overindulged in the use of alcohol, became disoriented and died shortly thereafter.

Necropsy revealed an old rheumatic mitral stenosis with focal calcification and ulceration of mitral valve; organized myocardial infarction of anterior portion of interventricular septum and posterior left ventricular wall; severe coronary atherosclerosis with occlusion of the two left anterior descending branches, partial occlusion of right coronary and left circumflex branch with organized thrombus; also bilateral thrombosis of internal carotid arteries. It is remarkable that with such a dif-

fuse multiple coronary infarction, he died a painless death. There were no symptoms of congestive failure prior to this last admission.

CASE III. A. E., sixty-eight year old white female, houseworker and dressmaker, complaining of symptoms of heart disease which had been present since 1926, following acute massive coronary thrombosis with pulmonary infarction. Since that time she has had ten admissions to various hospitals because of cardiac decompensation. Between these periods spent in hospitals her condition has been quite good and she has been able to carry on with her normal occupation. However, during the past three years, the free periods have been much shorter in duration, and not quite as free from symptoms.

The history contained the following points of interest: exertional dyspnea present for eight years, repeated attacks of paroxysmal nocturnal dyspnea; inability to lie flat for eight years, and at present sleeping on five pillows. Precordial pain was experienced only with the first attack. Edema of the legs, ankles, sacrum and abdomen had been present varying in degree for eight years.

Physical examination revealed a thin elderly dyspneic, orthopneic female. The neck veins were distended and pulsating. There was a diffuse precordial impulse; the apex was in the sixth space at the anterior axillary line;  $A_2$  greater than  $P_2$ , normal sinus rhythm, and a loud blowing apical systolic murmur. Her blood pressure was 176/100. The liver was four fingers breath below the costal margin. Moderate ankle, leg and sacral edema was present. There was a partial prolapse of the uterus.

Electrocardiogram showed normal sinus rhythm with marked left ventricular preponderance, and evidence of myocardial degeneration.

Diagnosis: Arteriosclerotic heart disease; essential hypertension; old coronary infarction; normal sinus rhythm; Class III.

Total thyroidectomy was performed on February 15, 1934, under cervical block anesthesia. No technical difficulties were encountered.

The postoperative course was uneventful; the patient was out of bed on the fifth day. The dyspnea was considerably lessened by the end of the first week.

The patient was readmitted during the eleventh postoperative week with symptoms of congestive failure which improved rapidly with digitalis and salyrgan. The symptoms

were mainly of water retention and have been on each of the subsequent admissions. In the eighth month she was readmitted again in moderate failure and remained in the hospital for six weeks; and again readmitted at the end of thirteen and a half months with congestive failure. The failure on each of these readmissions has always been due to an accumulation of fluid in the abdomen, strikingly out of proportion to the other symptoms of congestive failure. In the twentieth postoperative month she was readmitted with signs of congestive failure and ascites. Her course was progressively downward and she died December 26, 1935.

Necropsy revealed an old coronary infarct of the anterior wall of the left ventricle with an aneurysmal dilatation of the left ventricular wall and a left pulmonary infarct. There was bilateral hydrothorax, and chronic passive congestion of the liver and spleen, with ascites.

**CASE IV.** M. H., fifty years old, colored female, houseworker, first noticed symptoms of heart failure in January, 1932. This initial attack of decompensation lasted only a short time, and following this she was practically free from symptoms until June, 1933 when there was a severe break in compensation from which she never fully recovered, and was hospitalized from June, 1933 until the time of operation in April, 1934.

Physical examination revealed a well developed middle aged Negress, markedly dyspneic and orthopneic, with dilated and pulsating cervical veins. A few rales were heard at the bases of both lungs. There was a heaving pulsation at the apex which was in the seventh space in midaxillary line;  $A_2$  was greater than  $P_2$  and a loud systolic and short diastolic murmur at the apex; the sinus rhythm was normal with occasional extra systoles. Her blood pressure was 180/120. The liver edge was below the umbilicus and pulsating. No ascites was present, but there was marked edema of the ankles, sacrum and abdomen.

**Diagnosis:** Rheumatic heart disease; essential hypertension; mitral stenosis; normal sinus rhythm; Class III.

The prognosis was unquestionably poor, as there had been practically no improvement at any time in the eight months of hospital treatment. There was very little cardiac reserve power present, which was evidenced by the lack of response to treatment. The operative risk was considered as poor, and the procedure was undertaken only as a last resort.

Total thyroidectomy was performed on March 13, 1934, under cervical block anesthesia. The immediate postoperative improvement was extremely striking. The patient felt much more comfortable than she had been for eight months. The improvement however lasted for only two weeks, then symptoms of congestive failure recurred as it had been before the operation. Up to the present time, thirty-three months postoperative, there has been practically no further changes.

The basal metabolic rates were as follows:

|                             | Per Cent |
|-----------------------------|----------|
| Prior to the operation..... | - 2      |
| 2 weeks after.....          | -17      |
| 4 weeks.....                | -35      |
| 6 weeks.....                | -26      |
| 7 weeks.....                | -28      |
| 9 weeks.....                | -23      |
| 14 weeks.....               | -22      |

This case is regarded as a complete failure. The remarkable early improvement was interesting and occurred apparently long before there was any appreciable drop in the metabolic rate.

**CASE V.** J. M., fifty-nine year old white male, Customs' inspector, had his first attack of precordial pain in 1929; there were several additional attacks during that year, with a gradual increase in frequency and severity, until September 1933, when he experienced an unusually severe attack, diagnosed as an acute coronary occlusion. For the following six months he was practically bedridden because of pain. There was one more coronary closure in February, 1934, and he was thus forced to give up his normal occupation as a lieutenant in the Customs' Service, in June, 1933 because of exertional pain.

Physical examination revealed a well developed and nourished elderly white male. The lungs were clear. There was no precordial pulsation or thrill. The heart sounds were rather distant but no murmurs heard. His blood pressure reading was 134/82. The liver was not palpable. No ascites or edema was evident.

X-ray picture revealed a slight enlargement of the heart and a moderate dilatation of the aorta. The electrocardiogram showed normal sinus rhythm, left ventricular preponderance and myocardial changes associated with coronary artery disease.

**Diagnosis:** Arteriosclerotic heart disease; multiple myocardial infarction; dilatation of the aorta; Class III.

The patient had been under observation for one month, during which time the symptoms were obviously becoming more severe, nor had there been any improvement for some six months despite constant medical care and treatment. The outlook appeared to be hopeless unless relief could be obtained through total thyroidectomy.

Total thyroidectomy was performed on March 15, 1934, under cervical block anesthesia. The postoperative course was uneventful. There were no further attacks of pain from the time the operation was completed. There has been no return of dyspnea, heart consciousness or palpitation. Signs of myxedema appeared at the end of the first month, but were not severe until the fourth month. Thyroid feeding was not started until the twenty-third week, at which time the basal metabolic rate had fallen to minus 71 per cent.

Three years after the operation, the patient remains free from anginal attacks. However, as in Case XIII in this series, a severe peripheral neuritis developed during the eighth month affecting the upper extremities on both sides which prevents the patient from living normally.

CASE VI. S. B., fifty-four year old white male, an insurance agent, complained of symptoms of cardiac pain which have been present since 1925, when he had his first coronary vessel closure. In November, 1928 he had another coronary occlusion, and there was a third coronary vessel closure in December 1933.

Physical examination on admission showed an obese white male, emphysematous chest; heart slightly enlarged to the left, heart tones distant; no murmurs were heard; normal sinus rhythm. His blood pressure was 128/80. The liver margin was one finger's breadth below the costal margin. No ascites or edema was present.

X-ray picture revealed a slight enlargement of the transverse diameter of the heart and enlargement of the aorta. Electrocardiogram showed normal sinus rhythm, left axis deviation and marked myocardial damage.

*Diagnosis:* Arteriosclerotic heart disease; multiple myocardial infarctions; normal sinus rhythm; angina pectoris; Class III.

The prognosis without operation was unquestionably very poor. The symptoms were becoming gradually much more severe and relief could be obtained only by the use of morphine.

Total thyroidectomy was done on March 20, 1934, under cervical block anesthesia. The post-

operative course was uneventful. There was no recurrence of the pain after the operation and there has been no real attack up to the present time. There has been occasional mild sensations of oppression over the precordium following excessive exercise.

We feel that this case has been quite satisfactory as it has enabled the patient, who had been compelled to give up his occupation for seven years, to return to a comparatively normal life.

CASE VII. L. C., thirty-six year old male, machine operator, first noticed symptoms of heart disease in March, 1933, followed by two attacks of congestive failure which required hospitalization. The patient had an attack of acute rheumatic fever in 1916. In 1933 he began to suffer from dyspnea, orthopnea, precordial distress, forceful and irregular palpitation. There was a moderate degree of right upper quadrant tenderness, tenderness over the right renal area; diurnal frequency of micturition and nocturia.

Physical examination on admission revealed a poorly nourished dyspneic, orthopneic, cyanotic middle aged male. The neck veins were dilated and there was a right hydrothorax. The heart was greatly enlarged, the apex being in seventh space in the midaxillary line. Systolic and diastolic murmurs were heard at the apex and a diastolic murmur at the base; auricular fibrillation was present. His blood pressure was 180/110. The liver edge was three fingers breadth below the costal margin, tender and pulsating. No ascites or edema was noted.

An electrocardiogram showed a very low voltage and auricular fibrillation. The blood non-protein nitrogen was 45 mg. Urinalysis showed albumin 4 plus, and pus cells. Pyelograms showed bilateral renal calculi. Kidney function dye tests showed a marked renal impairment.

*Diagnosis:* Rheumatic heart disease; mitral stenosis; aortic insufficiency; auricular fibrillation; Class III. Bilateral nephrolithiasis and pyonephrosis.

The prognosis was extremely poor considering the extent of the renal involvement. There had been no improvement in the condition following admission, and which was rapidly becoming worse. The operative risk was considered as being very poor.

Total thyroidectomy was performed on March 20, 1934, under cervical block anesthesia. The condition of the patient was poor throughout.

The pulse varied from 80 to 140. There were no technical difficulties encountered. The gland was normal both grossly and microscopically.

The patient's condition was very poor at the close of the operation, and went rapidly downhill. Pulmonary edema set in and the patient died twenty hours postoperatively. No autopsy was obtained.

**CASE VIII.** L. M., sixty-two year old white female, hospital attendant, had two attacks of acute rheumatic fever, the first at seven years of age, the second at fourteen years. Symptoms of congestive failure were first noticed in 1927. During the following eight years there were 13 periods of hospitalization, of an average duration of two months. She was practically a bed invalid for this whole period of time, as there was never a sufficient degree of compensation obtained to permit her carrying on any activity.

Physical examination showed an obese, elderly, dyspneic, orthopneic female, with cyanosis of lips and engorged veins of the neck. Moist rales were heard at both bases. The apex was in the sixth intercostal space at the anterior axillary line;  $P_2$  greater than  $A_2$ , a double apical and an aortic diastolic murmurs were heard; there was a slow auricular fibrillation. Her blood pressure was 140/95. The liver was four fingers breadth below the costal margin and tender, irregular and nodular, but not pulsating. Massive edema of ankles, legs and over sacrum with many large varices in both legs were observed.

X-ray picture showed a marked enlargement of the heart in all diameters, with slight dilatation and moderate sclerosis of the aorta. Electrocardiogram showed slow auricular fibrillation and low voltage.

The basal metabolism rate was plus 1 per cent.

**Diagnosis:** Rheumatic heart disease; mitral stenosis; aortic insufficiency; auricular fibrillation; Class III. Bilateral varicose veins.

The prognosis without operation was considered very poor. The condition had not been benefited by any form of treatment to an extent which would permit her to regain a useful degree of compensation, even after long periods of hospitalization.

Total thyroidectomy was performed on April 4, 1934, under cervical block anesthesia. Apart from slight secondary hemorrhage and a mild degree of tetany, controlled by calcium and viosterol, the convalescent course was quite satisfactory. The patient was out of bed

on the fourteenth day. There was no further precordial distress.

There have been two readmissions to the hospital since operation, the first when she developed a widespread lobular pneumonia, seven months postoperatively. Despite an extensive consolidation and a severe general reaction with a high fever, the heart showed very few signs of decompensation and the patient came through the illness without difficulty. Eighteen months postoperatively, she was readmitted to the hospital with congestive failure, which cleared up with bed rest and salyrgan. At present she is taking digitalis 0.1 gm. q.d. to control the auricular fibrillation and  $\frac{1}{2}$  grain thyroid extract.

We feel this case to be a very striking result. A rather elderly woman has been enabled to regain a considerable amount of normal activity, after being a severe cardiac invalid for practically seven years, the last five of which were spent almost constantly in bed. Further the patient suffered from a widespread lobular pneumonia without any evidence of cardiac failure.

**CASE IX.** P. K., forty-six year old white male, a fruit dealer, since 1932 had been suffering from cardiac pain radiating from his wrist up toward the left shoulder, relieved by rest, nitroglycerine and amyl nitrite. There were no attacks suggesting coronary occlusion. Following the first attack of precordial pain, he was forced to give up his work because of the steadily increasing severity of the attacks. The three months prior to operation the patient spent in bed and suffered two or three attacks daily and nightly. For the past two years, he had been treated in the diabetic clinic as a moderately severe case of diabetes mellitus; he had a constantly high blood sugar and glycosuria but had not been given insulin due to the angina pectoris.

Physical examination on admission revealed a well nourished male, slightly dyspneic. The chest was emphysematous. The heart sounds were distant but of fairly good quality, and there was a normal sinus rhythm. His blood pressure was 138/60. The liver was not enlarged. No edema was present.

Roentgenogram showed slight enlargement of the heart and left ventricular curve; aorta not enlarged. Electrocardiogram showed low slurred R wave in the first and second leads,



with low voltage. The basal metabolism rate was plus 11 per cent.

**Diagnosis:** Arteriosclerotic heart disease; coronary sclerosis; angina pectoris; normal sinus rhythm; Class III. Diabetes mellitus.

The prognosis without operation was very poor, as he had been at bed rest for three months with the pain becoming gradually more frequent and severe.

Total thyroidectomy was performed on April 17, 1934, under cervical block anesthesia. The postoperative course was complicated by mild symptoms of tetany which were controlled by calcium and viosterol. The associated diabetes in this case was quite interesting; he had been on a diet of 120 gm. carbohydrates, 60 gm. fat, and 60 gm. protein; this diet was not changed following the operation. The preoperative blood sugar had ranged from 185 to 224 mgms. Two days after the operation the blood sugar had returned to within normal limits and the urine for the first time in three years became sugar-free. While the blood sugar has since returned to its previous high level the urine has remained constantly sugar-free during the entire postoperative period. It would seem that the kidney threshold of the sugar excretion had been raised.

We feel this case to be a very striking result. There has been no recurrence of cardiac pain up to the present time. During cold weather or following overexertion the patient experiences a mild feeling over the precordium. This has never been severe and it is of an entirely different nature to the pain before operation.

**CASE X.** R. S., forty year old white male, plumber, since 1930 had cardiac pain with typical radiation down the left arm, relieved by rest and nitroglycerin. In January, 1932 there was an acute coronary occlusion, following which the cardiac pain became much more severe and frequent, and he was thus forced to give up his normal occupation.

Physical examination on admission showed a well developed middle aged white male, chest clear, heart sounds clear; no murmurs heard. The pulse rate was 85 and regular. His blood pressure was 115/78.

Electrocardiogram showed normal sinus rhythm and myocardial changes from an old coronary vessel closure.

**Diagnosis:** Arteriosclerotic heart disease; coronary vessel closure; normal sinus rhythm; angina pectoris; Class III.

The prognosis without operation was very poor. The pain was becoming more severe and the attacks more frequent. He had been able to secure temporary relief by the use of amyl nitrite and nitroglycerine, but was unable to ward off their occurrence.

Total thyroidectomy was performed on May 12, 1934, under cervical block anesthesia. The postoperative course was uneventful. There has been no recurrence of pain from the time the operation was completed up to the present.

This case is considered as outstandingly successful. There has been no return of the pain since the operation, despite the fact that the patient has indulged in a great deal of exercise, against our advice strongly to the contrary.

He was carrying on rather heavy physical labor and died suddenly April, 1936. Necropsy revealed a complete gradual obliteration of both coronary arteries, and an organized myocardial infarction of the anterior portion of the intervalvular septum and posterior left ventricular wall.

It is remarkable that with multiple myocardial infarction due to repeated coronary vessel closure, he died without cardiac pain and oppression.

**CASE XI.** L. C., sixty-three year old white male, clerk, presented symptoms of cardiac pain since 1930, when he had substernal oppression and exertional pain. However in 1932 he had a coronary occlusion; following this the pain became much more frequent and severe and he was forced to give up his work. He took as much as 150  $\frac{1}{100}$  grain nitroglycerin tablets per week. Following the coronary closure, he began to have decubital and nocturnal pain.

Physical examination on admission revealed a dyspneic, orthopneic elderly male, with slightly distended and pulsating cervical veins. The apex was in the sixth intercostal space 14 cm. to the left of midsternal line. An apical systolic murmur was heard;  $A_2$  greater than  $P_2$ . The pulse rate was regular. The peripheral vessels were tortuous and thickened. His blood pressure was 160/110. The liver edge was two fingers breadth below the costal margin. There was no ascites or edema.

Skiagram revealed a moderately enlarged heart. Electrocardiogram showed inverted T waves in all leads, left axis deviation, partial A-V block, and defective bundle branch conduction.

*Diagnosis:* Arteriosclerotic heart disease; essential hypertension; coronary sclerosis; angina pectoris. Class III.

Prognosis without operation was considered as being poor. Purely medical measures were inadequate to prevent the attacks of pain which were becoming somewhat more severe.

Total thyroidectomy was performed on May 15, 1934, under cervical block anesthesia. The postoperative course was practically uneventful except for a pulmonary embolism. There was complete freedom from pain until the end of third week, when the patient began to have one or two attacks a day. These were of much less severity than the previous attacks and also relieved by nitroglycerin. In the eighth week, the pain began to be somewhat more severe and signs of decompensation appeared. Eleven weeks after the operation, the patient had a seizure while walking on the street and died immediately. No postmortem examination could be obtained, but it is practically certain that there was another coronary vessel closure.

CASE XII. H. B., fifty-four year old white male, policeman, had symptoms of cardiac pain since 1932, gradually increasing in severity. For the past year he had not been able to walk more than one block without resting, and he also had frequent attacks of paroxysmal nocturnal dyspnea. Edema of a mild degree had been present for two years. One kidney had been removed eight years previously, because of stones.

Physical examination revealed a dyspneic, orthopneic, elderly male, with distended veins of the neck. Rales were heard at both bases. The apex was in the sixth intercostal space 15 cm. to the left from midsternal line;  $P_2$  was greater than  $A_2$ ; a loud blowing apical systolic murmur and slow auricular fibrillation were evident. His blood pressure was 190/130. The liver edge was four fingers breadth below the costal margin. A moderate degree of edema of ankles and legs was present.

An electrocardiogram showed auricular fibrillation and marked left ventricular preponderance.

*Diagnosis:* Arteriosclerotic heart disease; essential hypertension; auricular fibrillation; congestive failure; Class IIB.

The prognosis was very poor as to the patient's ability of continuing his occupation, and it was hoped that a total thyroidectomy might enable him to resume his normal activity.

It was obvious that he was on a verge of congestive failure.

Total thyroidectomy was performed on May 19, 1934, under cervical block anesthesia, the operation lasting three-quarters of an hour. There was no injury to the recurrent laryngeal nerves. The condition of the patient was good up to the end of the operation, but as the skin clips were being applied he went into a comatose state and died immediately. A postmortem examination could not be obtained; but a spinal tap done at the time yielded a hemorrhagic fluid, and it was felt quite certain death was due to a cerebral hemorrhage.

CASE XIII. M. L., fifty-three year old white female, milliner, complained of symptoms of heart disease for three and one-half years with two bouts of congestive failure. She was followed in the cardiac clinic and it was decided to submit her to the operation of total thyroidectomy, in the hope that she might eventually be able to return to work.

Physical examination revealed a dyspneic, cyanotic, middle aged female with engorgement of the veins of neck. There were moist rales at both bases. The apex impulse was felt in the sixth intercostal space 13 cm. to the left from the midsternal line;  $P_2$  was greater than  $A_2$ ; a systolic and a diastolic murmur were heard at the apex, but there was normal sinus rhythm. Her blood pressure was 190/120. Slight pretibial edema was evident.

*Diagnosis:* Rheumatic heart disease (inactive); essential hypertension; mitral stenosis; sinus arrhythmia; Class IIB.

Total thyroidectomy was performed on August 29, 1934, under cervical block anesthesia. The postoperative course was uneventful and the patient was out of bed on the twelfth day. There was immediate relief of the palpitation, precordial pain and heart consciousness. The signs of congestive failure had disappeared by the end of the first week. Three and one-half months after the operation, at a time when she was able to resume her work, she developed signs and symptoms of a peripheral neuritis involving both the upper and lower extremities, on both sides, which have persisted up to the present time. We feel that this case, were it not for the unfortunate complication of the peripheral neuritis, would be strikingly successful. She is now thirty months postoperative and is completely free of any symptoms or signs of congestive heart failure.

CASE XIV. R. R., forty-seven year old white male, cabinet maker, complained of cardiac pain for eight months. There had been no major attacks suggestive of coronary occlusion, but the attacks had been occurring more frequently and at more regular intervals.

Physical examination revealed a rather obese, well developed male. The chest was clear. The apex was felt in the fifth intercostal space 12 cm. to the left of the midsternal line. The heart sounds were distant but clear. The pulse rate was regular. His blood pressure was 110/80.

Roentgenogram showed a moderate left ventricular hypertrophy; the aorta was normal. Electrocardiogram showed normal sinus rhythm and myocardial changes suggestive of coronary sclerosis.

*Diagnosis:* Arteriosclerotic heart disease; coronary sclerosis; angina pectoris; Class III.

The prognosis without operation was poor. There had been no diminution in the frequency or the severity of the attacks, despite rest and adequate medical treatment. The attacks were relieved but not prevented by the use of amyl nitrite. Inasmuch as there had been no definite coronary occlusion, it was felt that a good result should be obtained.

Total thyroidectomy was performed on August 29, 1934, under cervical block anesthesia. The voice became quite husky at the end of the operation until suddenly on the third post-operative day, edema of the larynx developed, causing a complete absence of motion of the vocal cords. However in five months time, the vocal cords moved in full excursion.

Sixteen months postoperative, the patient was working from six to eight hours a day, doing rather heavy carpentry. In December, 1936, the patient wrote stating that he was still engaged in heavy work with practically no discomfort.

CASE XV. T. L., forty-nine year old white male, a porter, had symptoms of congestive failure since January, 1934 and has had three admissions to Bellevue Hospital because of decompensation. Each time recovery followed rapidly with rest and treatment, and his compensation has been restored sufficiently to enable him to return to his occupation.

Physical examination on admission revealed a dyspneic, orthopneic, cyanotic middle aged male, with dilated and pulsating cervical veins. A right hydrothorax was present and moist rales were heard in both lungs. The apex was palpable in the sixth intercostal space 18 cm. to

the left of midsternal line. Austin Flint and aortic diastolic murmur and auricular fibrillation were also manifested. His blood pressure was 160/95. The liver edge was four fingers breadth below the costal margin. Moderate pretibial edema was present.

Teleroentgenogram showed a dilatation and sclerosis of the aorta and a markedly enlarged heart. Electrocardiogram showed auricular fibrillation and bundle branch block. The blood Wassermann was 4 plus.

*Diagnosis:* Syphilitic heart disease; aortic insufficiency; auricular fibrillation; Class III.

The prognosis without operation was poor, the free intervals were becoming shorter and the response to treatment a little slower. Total thyroidectomy was performed on August 30, 1934, under cervical block anesthesia. The post-operative course was uneventful. There have been five admissions since the operation fifteen months previously. Each time there has been small amounts of fluid in the right chest and abdominal cavity and a moderate degree of edema. Patient died suddenly November 17, 1935.

CASE XVI. G. T., thirty-nine year old white female, houseworker, had symptoms of heart disease for more than six years with four admissions to Bellevue Hospital during that time because of cardiac decompensation. Her condition in the intervals had been only fair, and for the last year and a half she had not been able to carry out her household tasks.

Physical examination on admission revealed a dyspneic, cyanotic, middle aged female with engorged veins of neck. There were moist rales at both bases. The apex was palpable in the sixth intercostal space 14 cm. to the left of the midsternal line. Systolic and diastolic murmurs at the apex and a diastolic murmur at the base, with slow auricular fibrillation were heard. Her blood pressure was 130/95. The liver was five fingers breadth below the costal margin, tender and pulsating. There was moderate pretibial edema of legs and ankles.

Teleroentgenogram showed a tremendously enlarged heart; the electrocardiogram showed auricular fibrillation and right axis deviation. The basal metabolism rate was plus 2 per cent.

*Diagnosis:* Rheumatic heart disease; mitral stenosis; aortic insufficiency; auricular fibrillation. Class IIB.

The patient had always compensated fairly quickly with hospital treatment, but not enough to allow of her leading an active life. It was

hoped that the operation would enable her to do this.

Total thyroidectomy was performed on September 18, 1934, under cervical block anesthesia. No technical difficulties were encountered. The postoperative course was entirely uneventful. At present, thirty months postoperatively, the patient is able to do all the housework and the cooking for four people, without any discomfort. We feel that this case is an excellent result.

#### SUMMARY AND CONCLUSIONS

Our studies to date comprising but 16 cardiac patients who have been followed for a period from twelve to thirty-two months are offered only as material to be

TABLE I

#### RESULTS OF ANSWERS TO STATISTICAL QUESTIONNAIRE ON TOTAL THYROIDECTOMY FOR HEART DISEASE

This operation has been done in 26 clinics.

Total number of operations..... 273

Operative mortality..... 6.9 per cent

#### Complications

Parathyroid tetany..... 8

Transient, mild, controlled by viosterol and calcium therapy.

Recurrent laryngeal nerve paralysis..... 13

4 of these temporary.

TABLE II

#### TOTAL THYROIDECTOMY FOR CONGESTIVE HEART FAILURE Results Obtained by Questionnaire

Number of Cases..... 173

#### Deaths

Immediate..... 16- 9.3%

Late—not related to the operation..... 30-11.5%

#### Clinical Results in 124 Patients

Markedly improved..... 52-41.9%

No recurrence of the signs or symptoms of congestive failure. Able to work.

Moderately improved..... 48-38.7%

Attacks of congestive failure less frequent and less severe. Unable to work.

No improvement..... 24-19.3%

TABLE III

#### TOTAL THYROIDECTOMY FOR ANGINA PECTORIS

#### Result Obtained by Questionnaire

Number of Cases..... 100

#### Deaths

Immediate..... 3- 3%

Late—not related to the operation..... 15-15%

#### Clinical Results in 82 Patients

Markedly improved..... 42-51.2%

No pain. No nitroglycerine.

Normal activity.

Moderately improved..... 33-40.2%

Mild attack of pain at irregular intervals. Occasional use of nitroglycerine.

No improvement..... 7- 8.5%

TABLE IV

#### TOTAL THYROIDECTOMY FOR ANGINA PECTORIS

#### Operated Cases

Number of Cases..... 6

#### Deaths

Immediate..... 0

Late not related to the operation..... 2

Coronary occlusion, 10 weeks postoperative; and coronary sclerosis, 2 years postoperative.

Markedly improved..... 3

No pain. No nitroglycerine. Normal activity.

Moderately improved..... 1

Mild attacks of pain, at irregular intervals.

Occasional use of nitroglycerine.

Slightly improved..... 0

Mild attacks of pain daily. Nitroglycerine as before the operation.

No improvement..... 0

#### Complications

Parathyroid tetany..... 1

Transient, mild, controlled by viosterol and calcium therapy.

Recurrent laryngeal nerve paralysis..... 1

Complete bilateral paralysis appeared on the third postoperative day. Normal movement returned by the end of the fourth month.

TABLE V

#### TOTAL THYROIDECTOMY FOR CONGESTIVE HEART FAILURE Operated Cases

Number of cases..... 10

#### Deaths

Immediate\*..... 2

Late, not related to the operation..... 1

from alcoholism 2½ years later.

Markedly improved..... 3

No recurrence of the signs or symptoms of congestive failure. Able to work.

Moderately improved..... 2

Attacks of congestive failure less frequent, and less severe. Unable to work.

No improvement..... 2

Condition unchanged.

#### Complications

Parathyroid tetany..... 1

Transient, mild, controlled by viosterol and calcium therapy.

Recurrent laryngeal nerve paralysis..... 0

\* 1 death from a cerebral hemorrhage immediately following the operation; 1 death from pulmonary edema within 24 hours.

added to the growing mass from which ultimately conclusions regarding the essential value of total thyroidectomy for the treatment of heart disease will be drawn.

A group of patients suffering from cardiac decompensation or anginal pectoris, intractable to the usual medical measures, can be distinctly helped by total ablation of the thyroid gland. The benefit produced is sufficiently great in a large enough pro-

SUMMARY OF PATIENTS WITH CONGESTIVE FAILURE

| Case No. | Age | Sex | Date of operation | Diagnosis   | Symptoms Prior to Operation  | Basal Metabolism         |                     |                              | Blood pressure | Results   | Comments   |
|----------|-----|-----|-------------------|---|--|--------------------------|---------------------|------------------------------|----------------|---|--|
|          |     |     |                   |   |  | Post-operative, per cent | Myxoedema, per cent | On thyroid therapy, per cent |                |   |  |
| 1        | 49  | M.  | 2/9/34            | Rheumatic heart disease; mitral stenosis, aortic insufficiency, auricular fibrillation.   | Marked dyspnea and repeated severe bouts of congestive failure. Paroxysmal nocturnal dyspnea. Repeated periods of congestive failure since May 1933. Constant dyspnea, orthopnea, precordial palpitation.  | +38(?)<br>+17            | -42                 | -15                          | 116/90         | Markedly improved.  | Ambulatory, comfortable for 19 months.   |
| 2        | 40  | M.  | 2/9/34            | Arteriosclerotic heart disease; essential hypertension, auricular fibrillation.   | Repeated bouts of decompensation since 1926. Attacks of paroxysmal nocturnal dyspnea for 8 years. For the past year she had not been able to walk more than a block without resting. Edema of legs had been present varying in degree for 8 years.                       | +2                       | -48                 | -16                          | 150/100        | Markedly improved for 2½ years when death occurred from alcoholism. | Patient now working, there has been no recurrence of symptoms of congestive failure. He has been enabled to return to active life and to carry on heavy physical labor. Readmitted to hospital 3 times since operated on, for accumulation of fluid in abdomen which improved rapidly with digitalis and salyrgan. |
| 3        | 68  | F.  | 2/15/34           | Arteriosclerotic heart disease; essential hypertension; normal sinus rhythm.  | Repetitive failure never completely cleared with bed rest, salyrgan and digitalis.   | +13                      | -22                 | -19                          | 176/100        | No improvement.   | This case is a complete failure. Patient still is in congestive failure.   |
| 4        | 50  | F.  | 3/13/34           | Rheumatic heart disease; mitral stenosis, normal sinus rhythm; essential hypertension; congestive failure.                          | Dyspnea and orthopnea, with congestive failure and edema of legs, requiring hospitalization since June 1933. Congestive failure never completely cleared with bed rest, salyrgan and digitalis.  | -2                       | -35                 | -22                          | 180/120        | No improvement.   | Marked renal impairment in case of congestive failure is contraindication for operation. Pulmonary edema set in and patient died 20 hours postoperatively.   |
| 7        | 36  | M.  | 3/20/34           | Rheumatic heart disease; mitral stenosis, aortic insufficiency, auricular fibrillation; bilateral nephrolithiasis and pyonephrosis. | Bedridden dyspnea, orthopnea, edema with history of 13 periods of hospitalization during past 7 years. Tenderness over right renal area, with nocturia and polyuria. Kidney function dye tests showed marked renal impairment. Albumin + + + + with clumps of pus cells. | -4                       |                     |                              | 180/110        | Immediate postoperative fatality.                                   | The dyspnea and orthopnea were markedly relieved. This elderly cardiac has been enabled to regain a considerable amount of normal activity after being cardiac invalid for 7 years. Cerebral hemorrhage just at end of operation.  |
| 8        | 62  | F.  | 4/4/34            | Rheumatic heart disease; mitral stenosis, aortic insufficiency, auricular fibrillation; anevrism, edema of legs.                    | Bedridden dyspnea, orthopnea, edema with history of 13 periods of hospitalization during past 7 years. Mitral congestive failure in 1927 and since then unable to carry on any form of activity.   | +1                       | -29                 | -19                          | 140/95         | Moderate improvement.   | Completely free of congestive failure three and one-half months after operation developed a peripheral neuritis. Postoperative 4 episodes of decompensation, with readmission to hospital.   |
| 12       | 54  | M.  | 5/19/34           | Arteriosclerotic heart disease; essential hypertension; auricular fibrillation, congestive failure.                                 | Marked dyspnea for past 3 years and orthopnea. Persistent ankle edema for past 2 years.  | +25                      |                     |                              | 100/130        | Immediate postoperative fatality.                                   | At present patient is able to do all her housework, with no discomfort. Free of congestive failure.  |
| 13       | 53  | F.  | 8/20/34           | Rheumatic heart disease; mitral stenosis; essential hypertension; sinus arrhythmia; congestive failure.                             | Dyspnea and orthopnea and edema of legs since January 1934 requiring 3 admissions to hospital to become compensated. Accompanied by attack of paroxysmal nocturnal dyspnea. Right hydrothorax.   | +3                       | -25                 | -11                          | 180/120        | Markedly improved.  |  |
| 15       | 40  | M.  | 8/30/34           | Laetic heart disease; essential hypertension; aortic insufficiency; auricular fibrillation.   | 4 admissions to hospital within 6 years for congestive failure; bedridden for one and one-half years; dyspnea and orthopnea. Edema of legs constantly for one year.  | +2                       | -9                  | -7                           | 160/95         | No improvement.   |  |
| 16       | 39  | F.  | 9/18/34           | Rheumatic heart disease; mitral stenosis; aortic insufficiency; auricular fibrillation.   |  | +2                       | 33                  | -13                          | 130/90         | Markedly improved.  |  |

SUMMARY OF PATIENTS WITH ANGINA PECTORIS

| Case No. | Age | Sex | Date of Operation | Diagnosis  | Symptoms Prior to Operation  | Basal Metabolism         |                    |                              | Blood Pressure | Results  | Remarks  |
|----------|-----|-----|-------------------|--|--|--------------------------|--------------------|------------------------------|----------------|--|--|
|          |     |     |                   |  |  | Post-operative, Per Cent | Myxedema, Per Cent | On Thyroid Therapy, Per Cent |                |  |  |
| 5        | 59  | M.  | 3/15/34           | Arteriosclerotic heart disease; coronary sclerosis; angina pectoris; normal sinus rhythm.    | Cardiac pain on effort or rest since 1929, 1st coronary closure in Sept. 1933; 2nd coronary vessel closure in Feb. 1934. Cardiac pain unbearable; paroxysmal nocturnal dyspnea.  | -14                      | -71                | -17                          | 134/82         | Moderately improved.                                   | Now free from cardiac pain and paroxysmal nocturnal dyspnea. Had only 1 anginal seizure due to excess of thyroid extract. As in case 13, a severe peripheral neuritis developed which prevents the patient from living normally. There has been no recurrence of dyspnea, edema, palpitation or cardiac pain. Has occasional mild sensations of oppression over precordium following excessive exercise. |
| 6        | 54  | M.  | 3/20/34           | Arteriosclerotic heart disease; angina pectoris; multiple myocardial infarction.             | Cardiac pain since 1925 on effort and exertion. Angina decubitus since 1932. Acute coronary vessel closure in 1925, recurrence in Nov. 1928; also recurrence of coronary occlusion in Dec. 1933.   | -4                       | -30                | -10                          | 128/80         | Markedly improved.                                     | No recurrence of cardiac pain since operation. During cold weather or following overexertion experiences a mild feeling of pressure. Since operation blood sugar has returned to within normal limits and apparently the renal threshold has been raised.  |
| 9        | 46  | M.  | 4/17/34           | Arteriosclerotic heart disease; coronary sclerosis; angina pectoris; diabetes mellitus.      | Effort since 1932 radiating down to left wrist. Bedridden for 3 months prior to operation and still suffered daily, 5 to 6 attacks, and cardiac pain becoming more frequent and severe.  | -11                      | -23                | -7                           | 138/60         | Markedly improved.                                     | No recurrence of cardiac pain since operation. During cold weather or following overexertion experiences a mild feeling of pressure. Since operation blood sugar has returned to within normal limits and apparently the renal threshold has been raised.  |
| 10       | 40  | M.  | 5/12/34           | Arteriosclerotic heart disease; coronary sclerosis; angina pectoris.                         | Cardiac pain since 1930. Coronary thrombosis in Jan. 1932, following which his pain became more frequent and severe. Prior to operation could only walk one block slowly before pain would occur.  | -4                       | -46                | -12                          | 115/78         | Markedly improved, until sudden death two years later. | No recurrence of pain from the time of total thyroidectomy despite the fact that patient has indulged in a great deal of exercise, strongly against our advice. Fully capable of undertaking moderate amount of work.  |
| 11       | 63  | M.  | 5/15/34           | Arteriosclerotic heart disease; essential hypertension; coronary sclerosis; angina pectoris. | Cardiac pain since 1930, brought on by exertion; following coronary infarction in 1932, pain became more frequent and severe; angina decubitus and nocturnal dyspnea. Prior to operation could only walk one block. Nitroglycerine would control the pain during the attacks, requiring 100 to 150 tablets per week. | -15                      | -17                | -13                          | 160/110        | Death within 11 weeks postoperative.                   | Complete freedom from pain during postoperative course until end of third week when had recurrence of mild attacks of anginal pain, relieved by nitroglycerine. In eighth week pain became more severe and signs of decompensation appeared. On eleventh week had an acute coronary thrombosis and died immediately.   |
| 14       | 47  | M.  | 8/29/34           | Arteriosclerotic heart disease; coronary sclerosis; angina pectoris.                         | Symptoms of cardiac pain present since January 1934, brought on by exertion and relieved by amyl nitrite. Lately attacks occurring at night and he has not been able to resume work since then.  | -2                       | -35                | -22                          | 110/80         | Moderately improved.                                   | Patient is working from six to eight hours a day doing rather heavy carpentry. Occasional mild attacks of pain, at irregular intervals necessitating occasional use of nitroglycerine.   |

portion of cases to justify such a radical surgical procedure. Such a major operation can be carried out in patients suffering from serious heart disease with an astonishing low operative mortality rate.

The successful outcome of any case depends first, on a very careful selection and thorough preoperative study of the patient, and secondly on an organization which can assure a continuous postoperative supervision and follow-up. Ambulatory patients who have been subjected to total thyroidectomy for the improvement of heart disease unquestionably require more frequent and closer observation than those not operated upon because all of these patients require the administration of dessicated thyroid extract; the determination of adequate dosage demands careful and frequently repeated clinical observations and repeated basal metabolic rate and blood cholesterol determinations.

The operative procedure of total thyroidectomy as a means of treating angina pectoris has opened paths of approach to the study of cardiac pain and the conditions surrounding its occurrence heretofore unavailable and has enlarged and will continue to add immeasurably to our knowledge of the subject.

## REFERENCES

- BLUMGART, H. L. Velocity of blood flow in health and disease. *Medicine*, 10: 1, 1931.
- BLUMGART, H. L., GARGILL, S. L. and GILLIGAN, D. R. Circulation in myxedema with a comparison of the velocity of blood flow in myxedema and thyrotoxicosis. *Jour. Clin. Investigation*, 9: 91, 1930.
- BLUMGART, H. L., LEVINE, S. A. and BERLIN, D. D. Congestive heart failure and angina pectoris. The therapeutic effect of thyroidectomy on patients without clinical or pathological evidence of thyroid toxicity. *Arch. Int. Med.*, 51: 866, 1933.
- BLUMGART, H. L., RISEMAN, J. E., DANS, D. and BERLIN, D. D. Therapeutic effect of total ablation of normal thyroid gland on congestive heart failure and angina pectoris. *Arch. Int. Med.*, 52: 165, 1933.
- CUTLER, E. C., and SCHNITKER, M. T. Total thyroidectomy for angina pectoris. *Ann. Surg.*, 100: 4, 1934.
- FRANCK, FRANCOIS. Signification, physiologique de la resection du sympathique dans la maladie de Basedow. *Bull. Acad. de méd. Paris*, 41: 565, 1899.
- JONNESCO, T. L. Traitement chirurgical de l'angine de poitrine par la resection du sympathique ceruicothoracique. *Bull. Acad. de Méd. Paris*, 84: 93, 1920.
- KOCHER, A. and BASEDOW, WEBER MORBIUS. *Mitt. a.d. Grenzgeb. d. Med. u. Cbir.*, 9: 1, 1902.
- LEVINE, S. A., CUTLER, E. C. and EPPINGER, E. C. Thyroidectomy in the treatment of advanced congestive heart failure and angina pectoris. *New England Jour. Med.*, 209: 14, 1933.
- LEVINE, S. A. and EPPINGER, E. C. Further experiences with total thyroidectomy in the treatment of intractable heart disease. *Am. Heart Jour.*, 10: 6, 1935.
- LYON, J. A., and HORGAN, E. Dissociation of the thyroid from the sympathetic nervous system and reduction of the blood supply to the thyroid in angina pectoris. *Jour. South. Med. Ass.*, 27: 12, 1934.



# THE TRUSS IN RELATIONSHIP TO DIAGNOSIS AND INJECTION TREATMENT OF INGUINAL HERNIA\*

FRANKLIN I. HARRIS, M.D., F.A.C.S. AND ALFRED S. WHITE, M.D.

SAN FRANCISCO, CALIF.

THE revival of interest on the part of the medical profession in the treatment of hernia by injection has disclosed the startling fact that there is practically complete ignorance and no authoritative information on the all important subject of trusses. As a more complete understanding of the theory and the value of the injection method has developed, it has become increasingly evident that the success or failure of this method of treatment is in a great measure dependent on the use of proper trusses for the given case. Early in their study of the injection method of treatment the authors reviewed the literature in an attempt to find a scientific exposition of the theory and mechanics of truss manufacture and fitting but could find none. The scarcity of articles based on scientific study prompted us to undertake an investigation along these lines.

The prerequisites for the treatment of a hernia by the method of injection are first, that the hernia be completely reducible, and second, that it can be held in complete reduction during the entire duration of treatment. The method of holding the contents of the sac in complete reduction involves the use of an externally fitted apparatus. If such an appliance allows the contents of the sac to distend the canal before firm fibrous tissue is deposited, the treatment fails and the method is unjustly condemned. In our early experience with this form of treatment recurrences developed in certain cases after apparent closure. These were later successfully treated and permanently closed by changing the type of truss. This change at first was more or less haphazard and all types

and makes of trusses were used. It was found, however, that the response to the injection therapy varied tremendously with the different types of trusses and that certain types particularly reduced the recurrence rate markedly and aided in giving a quick firm closure.

In our early experience with the injection method, we adapted the German scrotal truss, which has a wide usage and has been sold extensively by trussmakers for the treatment of inguinal hernia. This truss consists of a semicircular spring with a triangular shaped pad and is designed to exert pressure over the inguinal canal. Examination of a patient with the truss in position shows the hernia apparently reduced. With a reducible hernia and this type of truss a successful cure of the hernia was anticipated when the proper injection technique was used. However, the fact that cures did not always result led to a more careful consideration of the truss and its relationship to the anatomy of the inguinal canal. It was immediately apparent that the construction and fitting of a truss, and its use in the injection treatment, was by no means a simple thing but that its formation and employment depended on the complex anatomy of inguinal hernias, and the little considered activity of the large muscles of the trunk and thigh which continually cause movement around the encircling band of the truss.

## ANATOMICAL CONSIDERATIONS

The inguinal canal is an oblique cleft in the inguino-abdominal wall above the mesial half of the inguinal ligament, and in the adult its length varies between 4 and 5 cm. The abdominal opening or inlet of

\* From the Department of Surgery, Mount Zion Hospital, San Francisco. Service of Dr. Harold Brunn.



the canal, the internal ring, is located in the transversalis fascia about 1 cm. above the center of the inguinal ligament. The

indirect hernias, the latter (Fig. 2) as direct, and it is obvious that an externally placed truss must take these anatomical

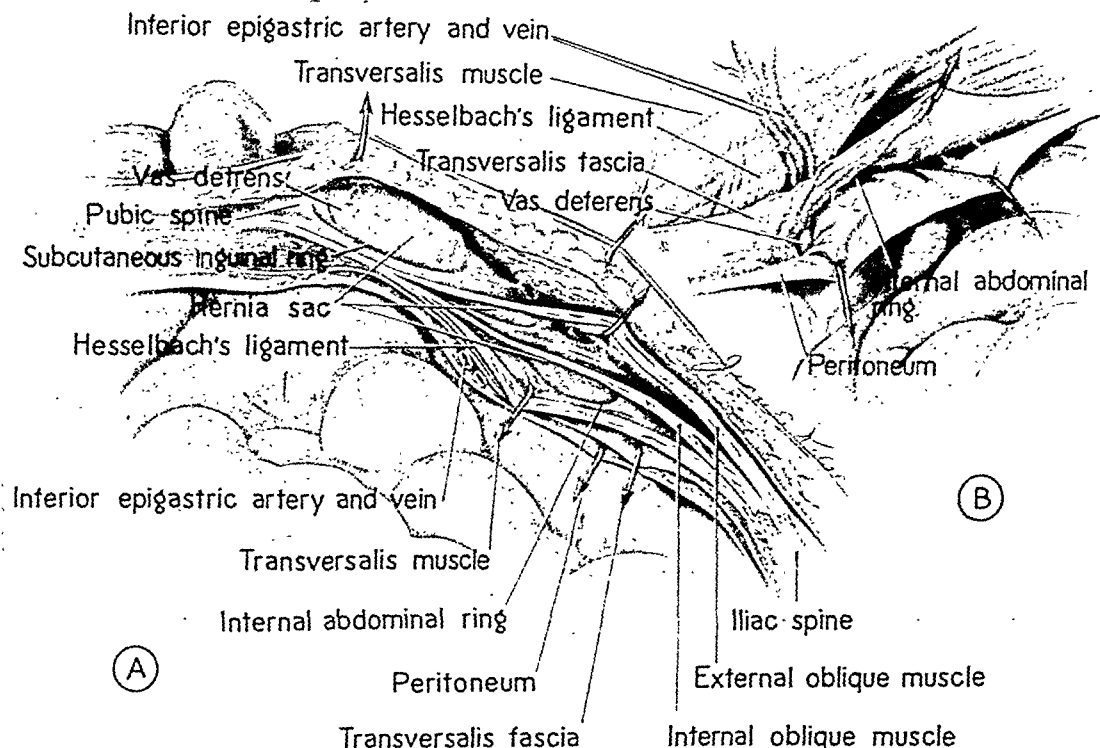


FIG. 1. Semidiagrammatic drawing illustrating indirect inguinal hernia. A, view from in front and above. Note the contents of the sac leaving the abdominal cavity through the internal ring and traveling down through the inguinal canal to emerge through the external ring. B, view from the inside of the pelvis.

outlet, the external ring, is located in a deficiency in the aponeurosis of the external oblique which lies immediately above the crest of the pubis. The superior and deep end of the canal is lateral to the inferior and superficial end. Any increase in the intra-abdominal pressure forces the anterior and posterior walls of the canal together and aids in the support of the abdominal wall.

The varieties of inguinal hernias which may develop in this region may be classified into two principal groups: those that leave the abdomen lateral to the inferior epigastric artery, through the internal ring, and pass down the length of the inguinal canal; and those which leave the abdomen through the middle inguinal fossa, mesial to the inferior epigastric artery, and enter the inguinal canal near to the external ring. The former (Fig. 1) are known as

relationships into account if complete reduction of the hernia is to result. In the case of an indirect inguinal type of hernia it is easily seen that the pressure of the truss must be directed over the point of exit of the hernia, namely, the internal ring. Since the canal is 4 to 5 cm. long, pressure exerted lower along the canal, below the internal ring, allows for partial descent of the sac contents above the truss. The resultant separation of the wall of the inguinal canal and the distention of the sac, however, is masked by the truss pad and gives the erroneous impression that the hernia is completely reduced. Similarly, if the pressure is exerted over the external ring, the hernia is apparently reduced or at least prevented from dropping into the scrotum in the case of a complete hernia, but in actuality the canal remains dis-

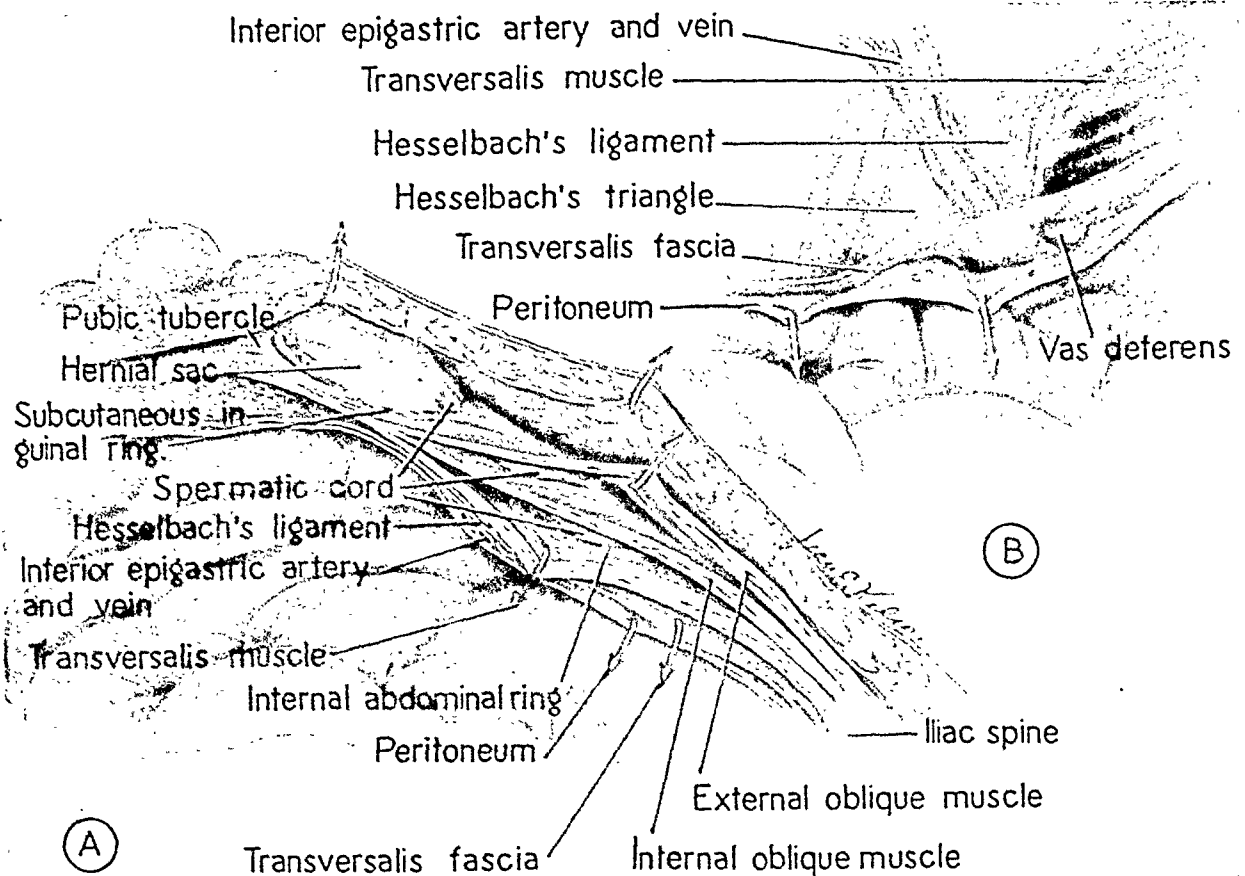


FIG. 2. Semidiagrammatic drawing illustrating direct inguinal hernia. A, view from in front and above. Note the contents of the sac leaving the abdominal cavity through Hesselbach's triangle and emerging through the external ring. B, view from the inside of the pelvis.

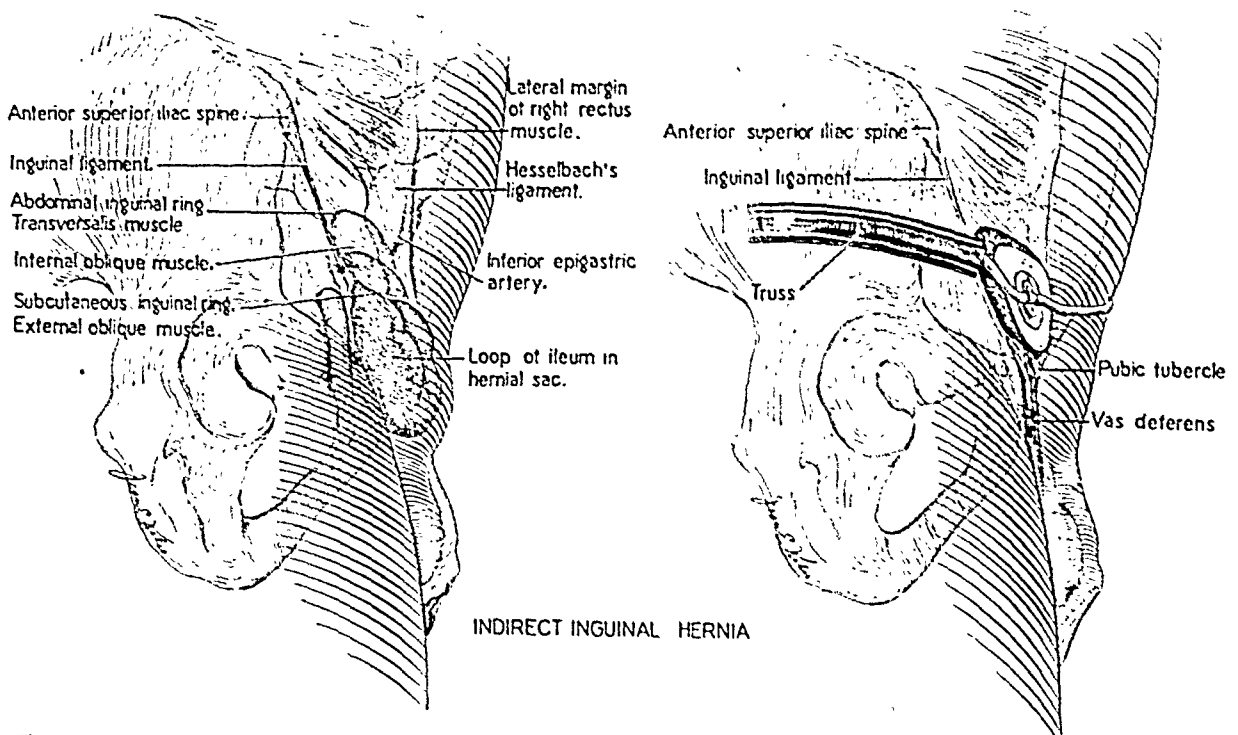


FIG. 3. Diagram to show the mechanism by which a truss maintains the reduction of an indirect inguinal hernia. Note the pressure of the truss over the internal ring.

tended with sac contents. Any truss then that is improperly placed or is so constructed that its point of maximum pres-

approximation, in the region of the internal ring, in order to prevent the descent of the sac contents. It is not the purpose of the

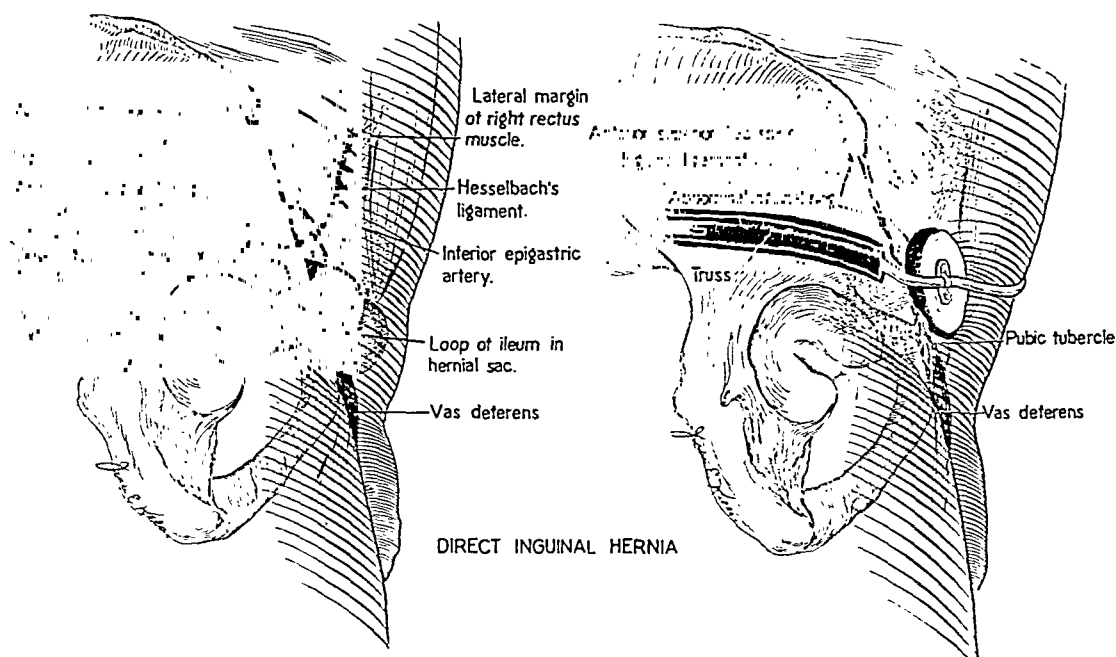


FIG. 4. Diagram to show the mechanism by which a truss maintains the reduction of a direct inguinal hernia. Note the pressure of the truss over Hesselbach's triangle.

sure is below the internal ring allows the rupture to occupy the upper portion of the inguinal canal and is not only anatomically unsound but useless for the injection treatment of hernia. This simple but all important fact has never been given the emphasis it deserves, for on it rests the successful outcome of treatment of indirect inguinal hernia by injections (Fig. 3).

The placement of the point of maximum pressure in a direct hernia must be over the area of deficiency in the inguinal wall through which the hernia protrudes. A truss fitted over the internal ring, in a direct hernia, will not aid in keeping the hernia in reduction. Rather the point of pressure must be over Hesselbach's triangle (Fig. 4).

The second important point in the consideration of the relationship of the truss to the anatomy of the inguinal canal concerns the direction of pressure exerted by the truss through the canal. In an indirect hernia, it is seen that the object of the truss is to hold the muscular layers in close

truss to hold the sac contents up in any way. An approximation of the muscular layers is not only the most effective method of holding the hernia, but it completely coincides with the normal muscular activities in that region. It is true that upward and backward pressure is necessary to reduce a hernia, but a similar pressure maintained by a truss following reduction would merely act by closing the external ring. It would allow the contents of the sac to remain within the inguinal canal, with the protruding portion of the bowel resting upon the pad. For the maximum pressure, then, the line of force must be through the canal at right angles to the truss pad. This cannot be achieved by the sort of simple encircling band used in most trusses. It is necessary to construct a fulcrum extending from the posterior band of the truss downwards over the buttock, so that the direction of pressure extends from the central portion of the pad to the lowermost portion of the fulcrum. This counterpressure posteriorly should be

somewhat lower than the center of the pad, making the line of pressure downwards and backwards (Fig. 5, B). The

the band to lower itself to the neutral level, the pad is forced downward away from the internal ring and the truss fails to hold the

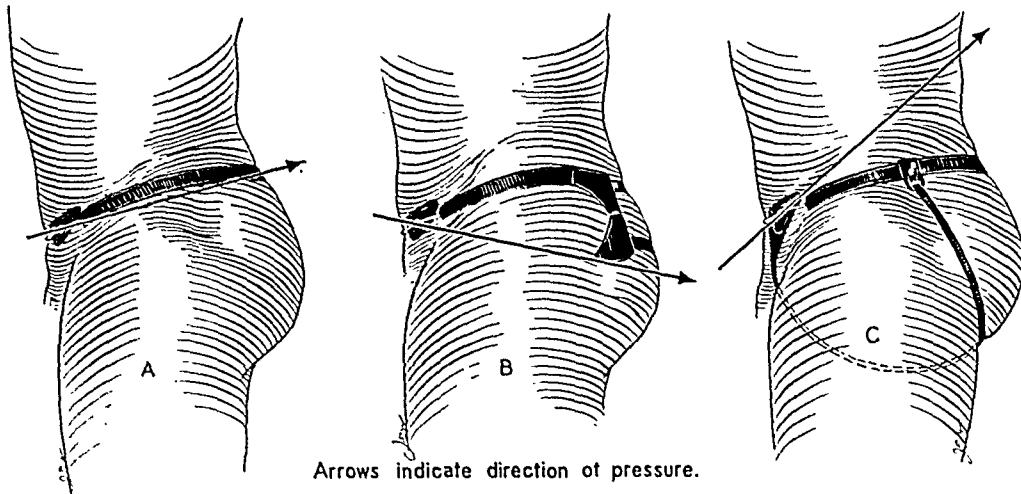


FIG. 5. Diagram to show the direction of pressure exerted through the inguinal canal by various types of trusses. A, Rigid Truss: Posterior counterpressure too high. The line of force travels upwards and reduces the efficiency of the truss. B, Semirigid Truss: Correct posterior counterpressure. Line of force at right angles through inguinal canal. C, Spring Truss: Posterior counterpressure too high. The leg strap pulls the upper portion of the pad outward, thus directing the line of force so high that the pressure over the internal ring is negligible.

correct anatomical placement of this line of force maintains reduction of the hernia with the least amount of pressure. This type of truss is likewise suitable for direct hernia.

The third anatomical consideration that must be treated concerns the relationship of the internal ring to the activity of the large muscles of the trunk and thigh. The encircling band of the truss, when placed around the lower trunk, is shifted in position by the movements of the body and leg until it occupies the area of least motion between the trunk and the thigh. This neutral point is midway between the crest of the ilium and the trochanter of the femur, above the active muscles of the thigh and below those of the abdomen. In this position the end of the encircling band rests immediately over the internal ring, and the pad which is fixed thereto must be on a direct line with the band to be anatomically correct. In most trusses the pad curves downward from the encircling band, and when the pad is placed over the internal ring the encircling band is much too high. As movement of the body causes

hernia in reduction. The same situation holds true in a direct inguinal hernia. The area of weakness in Hesselbach's triangle is likewise on a line with the neutral area of muscular action, and the truss pad must be centered on the line of the encircling band.

These, then, are the important factors in the consideration of a truss for a hernia which is to be treated by the injection method: (1) its accurate placement over the internal ring, in an indirect hernia, and over Hesselbach's triangle in a direct hernia; (2) the necessity of pressure through the inguinal canal, by means of a low posterior fulcrum at right angles to the truss pad; and (3) the necessity of having the truss pad on a line with the encircling band of the truss.

*Dangers if the Anatomical Considerations Are Neglected.* The importance of these factors cannot be overemphasized, and their importance is best realized when consideration is given to the dangers and complications which may occur when they are neglected.

1. When the pad is placed away from the internal ring:

In this situation the bowel is constantly filling the upper portion of the canal and resting on the pad. This completely nullifies the purpose of the injections, since the constant distention of the sac causes separation of the walls of the inguinal canal. The newly formed fibrous tissue is broken down and the hernia fails to close. Even when only the very uppermost portion of the canal is left open, and the hernia seems cured following the injection treatment, that small opening at the internal ring acts as a wedge which finally results in a recurrence, due not to the fault of the treatment but rather to an incorrect truss. A truss placed too low as just described is likewise dangerous, as the bowel may easily work its way around the pad and become strangulated.

2. When the line of force of the pad is not at right angles to the canal:

A truss so constructed as to give the improper line of force through the inguinal canal fails to give close approximation of the walls of the canal, and allows partial descent of the contents of the sac. This is accompanied by the dangers mentioned. The higher the posterior portion of the truss as it encircles the body, the higher is the line of pressure and the less efficient the truss (Fig. 5). With this type of truss very much more pressure is necessary to maintain reduction of the hernia than with the proper truss. Attempts to use such a truss make the application of extremely great pressure necessary, and excoriation of the skin of the inguinal region and back are the result. Such an area makes continuation of the injection treatment impossible.

3. When the truss pad is not on a line with the encircling band of the truss:

This assumes grave importance when the results of the use of this type of truss are considered. With the pad placed lower than the encircling band, it is seen from the above mentioned anatomical considerations that the muscles of the trunk and thigh will inevitably move the encircling

band down from its too high position. This immediately moves the pad away from the inguinal canal, and allows for descent of the sac contents, which by no means is the only danger. The pad itself is displaced over the pubic bone in which place it not only fails to aid in any way in retaining reduction of the hernia, but causes actual harm by compressing the spermatic cord between the pad and the bone. Considerable pain and swelling of the cord result, and in many cases atrophy of the testicle follows. Atrophy of the testicles has been noted, prior to the start of the injections, in our series, in 9.6 per cent of 300 patients with hernias. These patients have worn trusses for many years and the testicular atrophies present are undoubtedly due to this defect in the trusses which were worn by these patients.

#### TYPES OF TRUSSES

With these considerations in mind, the various types of trusses may be analyzed, and an evaluation made as to their anatomical and mechanical soundness, and as to their applicability to the injection treatment.

1. *Semirigid Truss.* This type of truss consists of a solid piece of phosphor-bronze covered with cowhide which encircles the hip at the neutral area of muscular activity. This bar has little spring but is so accurately fitted that it allows for no distention of the sac by its contents. Posteriorly there is a right angled projection of the bar, which extends downwards over the buttock, and gives pressure at right angles through the canal. The pad of the truss is made of either sponge rubber or factis. It is shaped to cover the canal and is attached to the end of the bar on a line with the encircling band. The correct position of the truss is maintained with the greatest comfort to the patient and with the least amount of harness. In either direct or indirect hernias, the muscles are firmly held in contact, thus insuring retention of the hernia. The truss is fastened and unfastened easily during treatment. The only

disadvantage of this truss is that it must be fitted by someone with experience and who has a knowledge of inguinal anatomy.

2. *Rigid Trusses.* Rigid trusses are of the frame type, and consist of a solid hoop of steel which surrounds the body, and

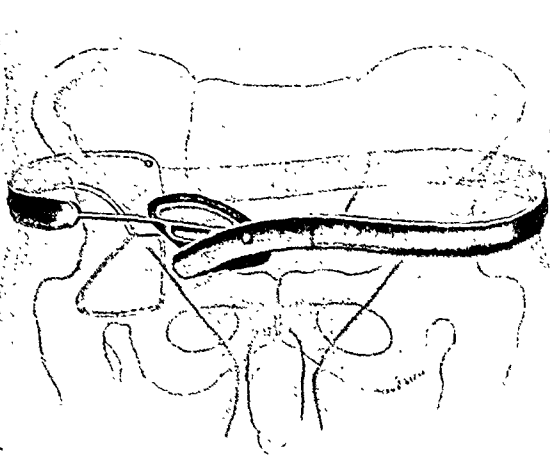


FIG. 6. Unilateral Semirigid Truss with single strap, front view. Note: (1) The correct placement of the encircling band at the area of least movement about the hips, halfway between the crest of the ilium and the trochanter of the femur. (2) The correct relationship between the pad and the encircling band. (3) The beveled sponge rubber anatomically correct pad.

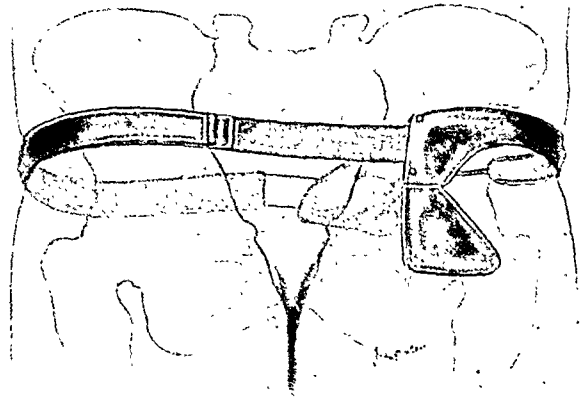


FIG. 7. Unilateral Semirigid Truss with single strap, back view. Note: (1) The posterior fulcrum giving the proper line of force through the canal. (2) The placement of the posterior fulcrum to the sacrum. (3) The beveled pad.

This type of truss may be procured in two forms, both of which are excellent and suitable for the injection treatment of

terminates within two inches of the spine posteriorly on either side. There may be circular pads attached to the posterior ends

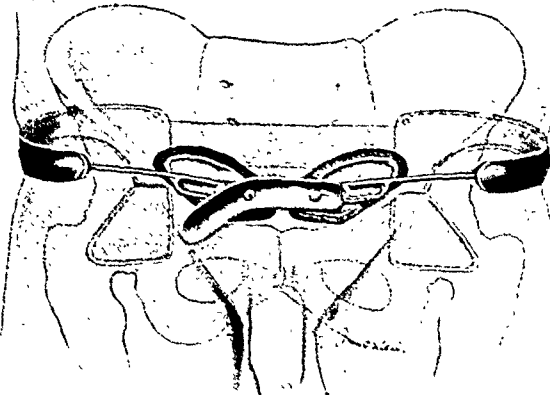


FIG. 8. Bilateral Semirigid Truss with single strap, front view.

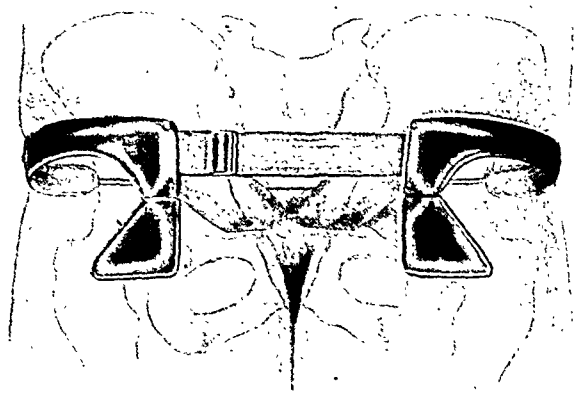


FIG. 9. Bilateral Semirigid Truss with single strap, back view.

hernia. The first, the semirigid truss with single strap, (Figs. 6, 7, 8, 9) is the easier to handle, and gives most comfort to the patient; but the second, (Figs. 10, 11, 12, 13) the semirigid truss with double strap is quite satisfactory.

of the hoop on the back, upon which the counterpressure is taken, or there may be instead a flat oblong disc which broadens the band at this point, and distributes the pressure over a greater surface. The truss pads are fitted in front and solidly fixed

to the bar. This type of truss does not depend on compression or spring action for its action. It merely acts as a resisting

heavy spring. As a matter of fact, great compression can be eliminated in this type of truss. It is essential that the sides of the

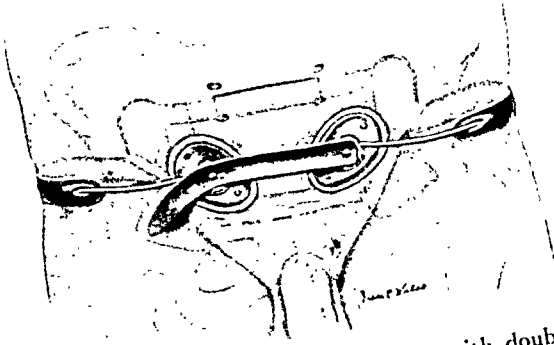


FIG. 10. Bilateral Semirigid Truss with double strap, front view. Note the oval shaped pads which are satisfactory but somewhat less efficient than the beveled sponge rubber pads.

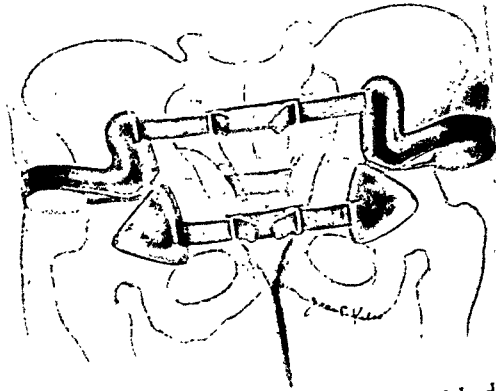


FIG. 11. Bilateral Semirigid Truss with double strap, back view. Note the two straps. The correct anatomical relationships are maintained.

framework about the pelvis, with the pad making firm pressure over the inguinal canal while the wearer is in the upright position. Any strain merely causes the

frame and the pad should be on the same line else as the frame takes its position over the quiet muscular area, the pad will then be forced too low.

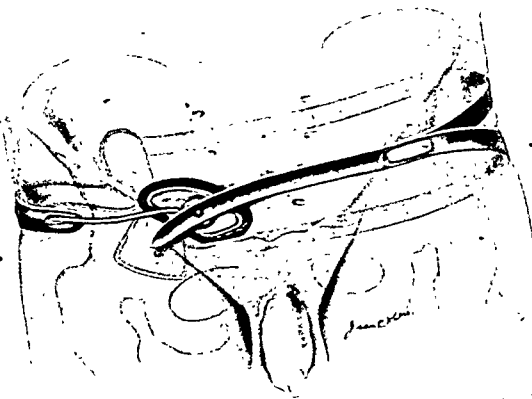


FIG. 12. Unilateral Semirigid Truss with double strap, front view. The diagram shows a beveled sponge rubber pad.

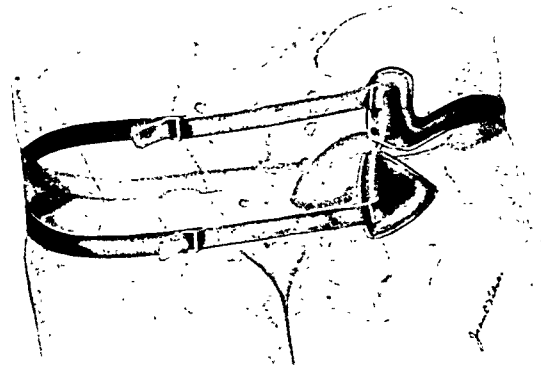


FIG. 13. Unilateral Semirigid Truss with double strap, back view.

abdominal wall to be thrown forward, and it is met firmly and restrained by the pad which is attached to the pelvic frame. On lying down the frame does not follow the receding surface of the abdominal wall. This truss can be constructed in an unsatisfactory fashion when its action is not understood, by making the frame of a

The frame truss has the advantage of carrying either one or two pads, but it is always best with two. The one over the side which is not ruptured may be very thin. A person with a rupture on one side, is apt to develop another on the other side; a possibility more likely to happen when a single truss is worn than when none

is used, since the pressure of the truss over the hernia throws the intra-abdominal pressure toward the other side. In the case of

Its principal disadvantage is that the posterior counterpressure is too high (Fig. 5, A) and for this reason, on many

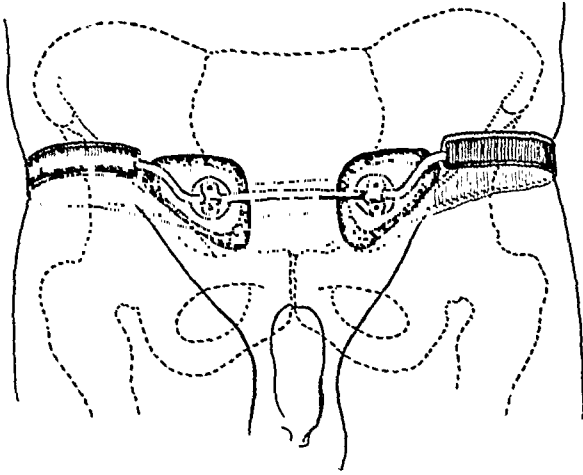


FIG. 14. The Frame Truss, simple frame type. See text for description.

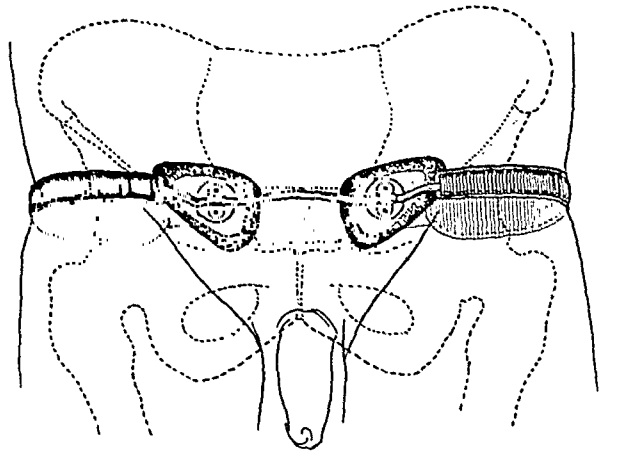


FIG. 15. The Frame Truss, short frame type. Note the shortened encircling band.

a double hernia, the solid front frame is desirable since there can be no change in the relative position of the pads, either from the stretching of a front strap, as in other forms of double truss, or through an error in adjustment.

Any increase in weight of the patient, and consequent change of size, is better taken care of by the posterior adjustment than by an adjustment in front. A person may gain or lose several inches in size without any relative change in the position of the two inguinal canals. Further advantages of this type of truss are, that it passes around the pelvis at the most immovable part, and that the pads are on a line with the frames. Surrounding both hips gives the truss stability, and it retains the hernias with almost the minimum of pressure.

people the truss will not stay in position; it is awkward to handle during injection; and with the frame extending around the body as it does, there is a tendency for the truss to become displaced while sleeping (Fig. 14).

In an effort to obviate these disadvantages several modifications of this type of truss have been made. In the first type (Fig. 15), the frame terminates about four inches from the spine on either side, instead of the usual two inches, and there is less displacement when the patient lies down. The second type (Fig. 16), the frame truss with bilateral curved low counterpressure and a single strap, directs the pressure through the canal at more nearly the proper angle. The third type, the frame truss with bilateral curved low counter-



pressure and double strap (Figs. 17 and 18), is extremely powerful and probably the most efficient truss made. It will hold

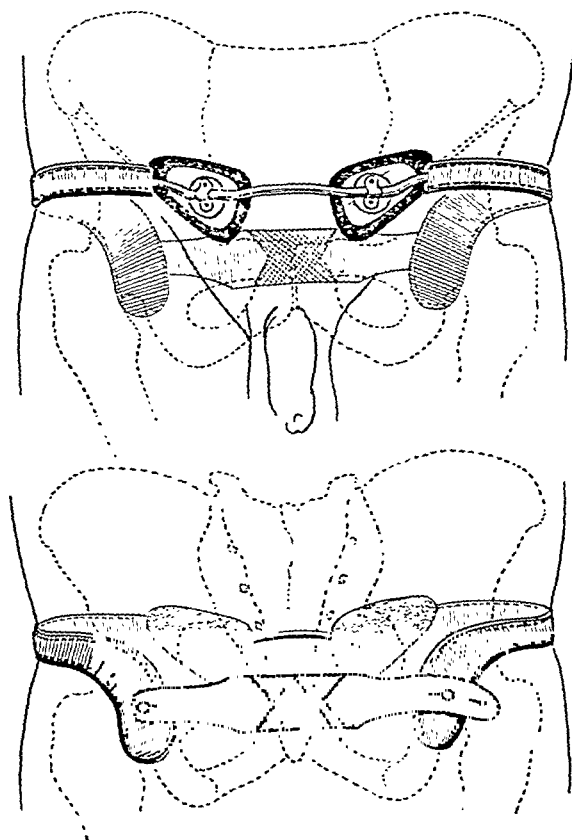


FIG. 16. The Frame Truss, single strap with bilateral low fulcrum. Note the bilateral curved posterior fulcrum and single strap.

ruptures impossible to hold with any other type. The bilateral posterior fulcrum, held by two straps posteriorly, prevents any abdominal strain from displacing the truss. The disadvantages of this type of truss are (1) that it requires special skill in fitting; and (2) that it is difficult to handle while giving injections. While all of these trusses are good, the simple frame truss and the shortened frame truss, are somewhat less efficient than the trusses in the semirigid group. The latter two, those with low counterpressure, however, are fully as satisfactory as the semirigid trusses, but have the disadvantage of being awkward to handle while injections are being given.

3. *Spring Trusses.* Spring trusses are made of a solid steel spring which extends from the inguinal region around to the

back, and is held in position by a leather strap. To it is attached a triangular shaped pad which covers the inguinal region. The truss retains the hernia by the compression of the spring. There are a number of variations of the spring type of truss, but with the possible exception of the English or rat-tail variety, they are unsuitable for the injection treatment of hernia. The principal types are known as the German (Fig. 19), French (Fig. 20), Scrotal (Fig. 21) and Chase (Fig. 22) trusses, and the criticisms which may be given for one, may be applied to all. The spring which extends to the back, on the same side as the pad, is too short to give the compression necessary to hold the hernia in reduction. The pads of this type of truss arch downward over the inguinal canal and are not on a line with the spring. When the pad is placed low over the pubic bone it allows the contents of the sac to descend to the external ring and while it temporarily prevents the hernial contents from entering the scrotum, it eventually produces a much larger hernia than was present originally. The worst feature of this truss is that, even if the pad is placed properly over the inguinal canal, it will in a short time drop down over the pubic bone, as the spring descends to the neutral point between the muscles of the thigh and abdomen.

The principal difference between the French and German types is that the French are much lighter, and usually have some decoration of fancy stitching upon the leather of the outer portion of the pad. The so-called Scrotal truss is even heavier than the German type, and the pad is made much larger in a vain attempt to remedy the defects inherent in this variety. The Chase truss consists of a spring of the French type, to which an iron neck curving downwards and holding a polished hard or soft pad is attached in front. The same defects are present in this truss also. With the spring type of truss the inguinal canal is seldom closed. In an effort to increase the pressure of the pad, an understrap is ap-

plied, extending from the pad between the legs to the strap behind. While this increases the pressure over the lower portion

been particularly unsuitable for the injection treatment of hernia.

The English or rat-tail type of truss

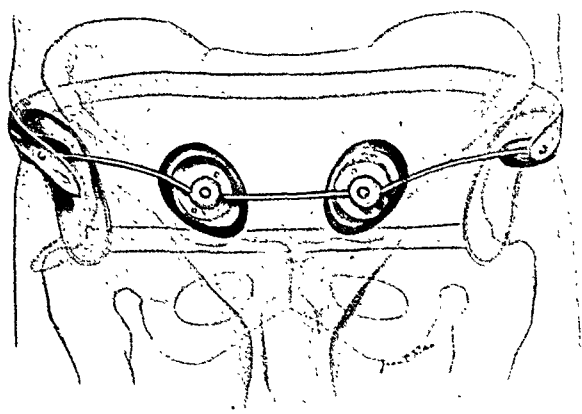


FIG. 17. The Frame Truss with bilateral curved posterior fulcrum and double strap, front view.

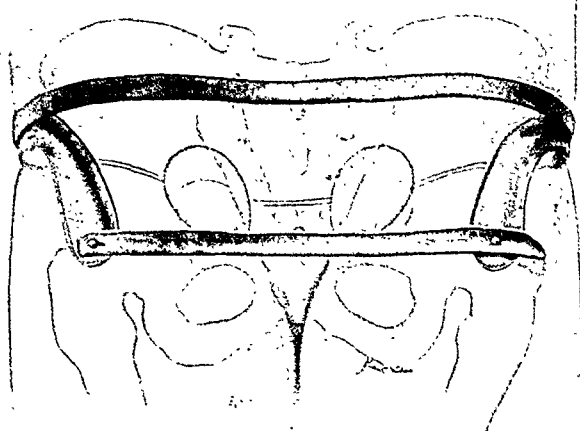


FIG. 18. The Frame Truss with bilateral curved posterior fulcrum and double strap, back view.

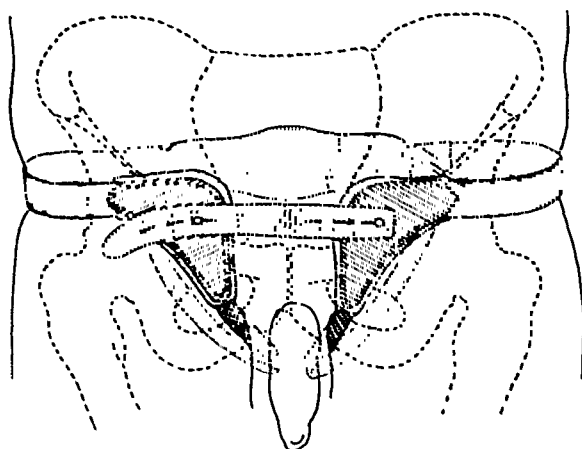


FIG. 19. Spring Truss, German type, double; front and back views.

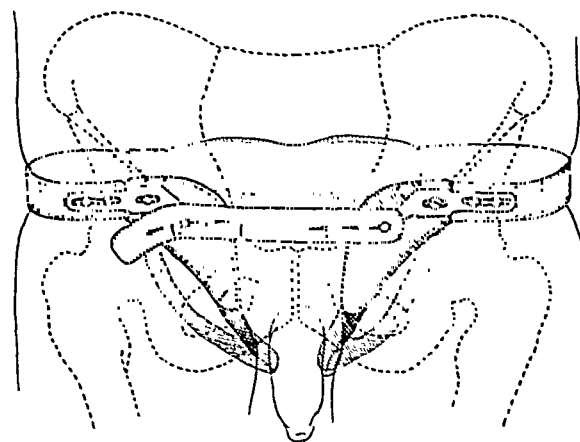
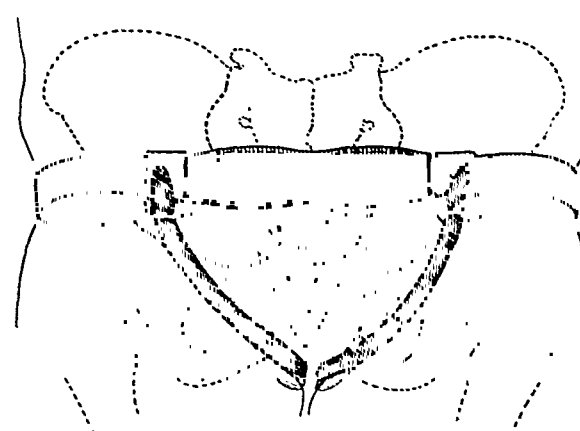
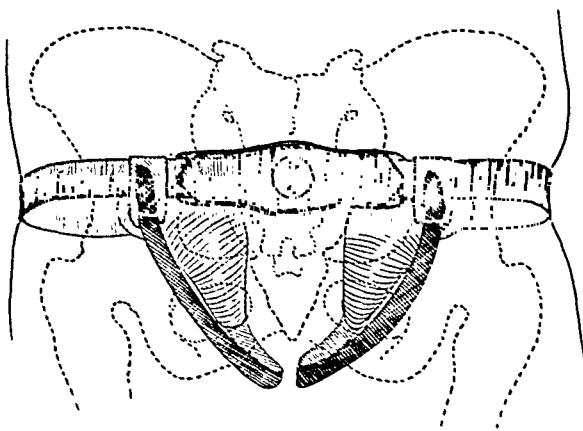


FIG. 20. Spring Truss, French type, double; front and back views.



of the pad, it shifts the line of force of the pressure even higher upwards, and opens the upper portion of the canal (Fig. 5, c). In our experience this type of truss has

(Fig. 23), while better than the other types in this group, is much inferior to the rigid or semirigid types. In this truss the encircling spring extends around the back to the

opposite hip, giving strong pressure over the inguinal canal, and the pad is on a line with the spring. An understrap is used to

that the pad is drawn down against the pubic bone by the perineal strap. This leaves the upper part of the canal unpro-

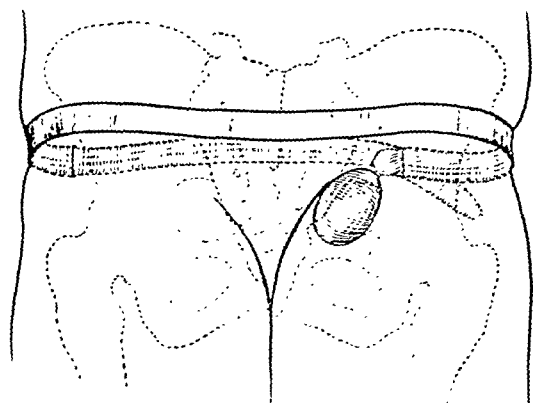
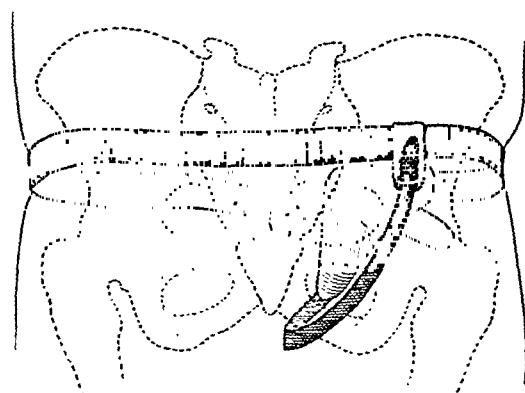
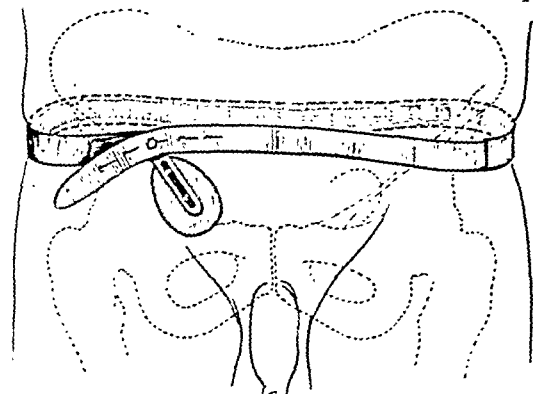
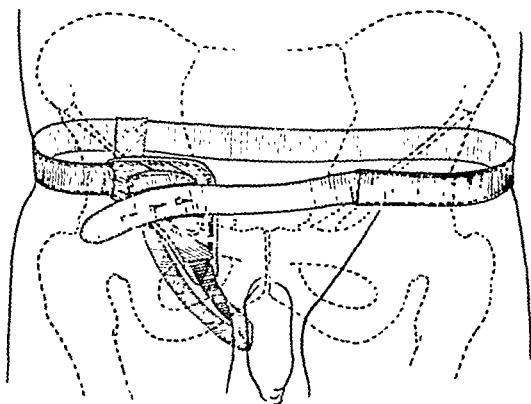


FIG. 21. Spring Truss, Scrotal type, single; front and back views.

FIG. 22. Spring Truss, Chase type, single; front and back views.

increase the pressure. The principal disadvantage is that the counterpressure is much too high, since there is no posterior fulcrum.

4. *Elastic Trusses.* The elastic truss, so called because it is made of heavy elastic web, consists of a strong pelvic belt to which is attached a good sized pad, held down by a perineal strap (Fig. 24). The perineal strap, as it buttons to the lower portion of the pad, turns the lower end of the pad under, so as to give an upward as well as a backward pressure.

The elastic truss is the most frequently used truss in this country because it requires no fitting; anyone with a hernia can apply one with little trouble. Usually if worn for any length of time, they are instrumental in producing an increase of the size of the hernia. This is due to the fact

tected and consequently occupied by part of the hernia. A hernia held in this fashion at the external ring is sure to increase in size. This type of truss would be more satisfactory if the pelvis were entirely round but since the transverse diameter of the pelvis is one-third larger than the anteroposterior diameter, this type of truss is thoroughly unscientific.

A flexible band drawn tightly around the hips produces far more pressure over each hip than over the inguinal region, where the pressure is most necessary. A band placed in this position will not remain in its position without the perineal strap. This type of belt fails to place the pressure over the internal ring where it is most needed, but rather the pad presses over the pubic bone and over the external ring, allowing the upper portion of the inguinal canal to

be constantly filled with a loop of bowel or a piece of omentum. Furthermore, the pad compresses the spermatic cord against the

group are most preferable. For many patients trusses of the frame group without low counterpressure may be used, but gen-

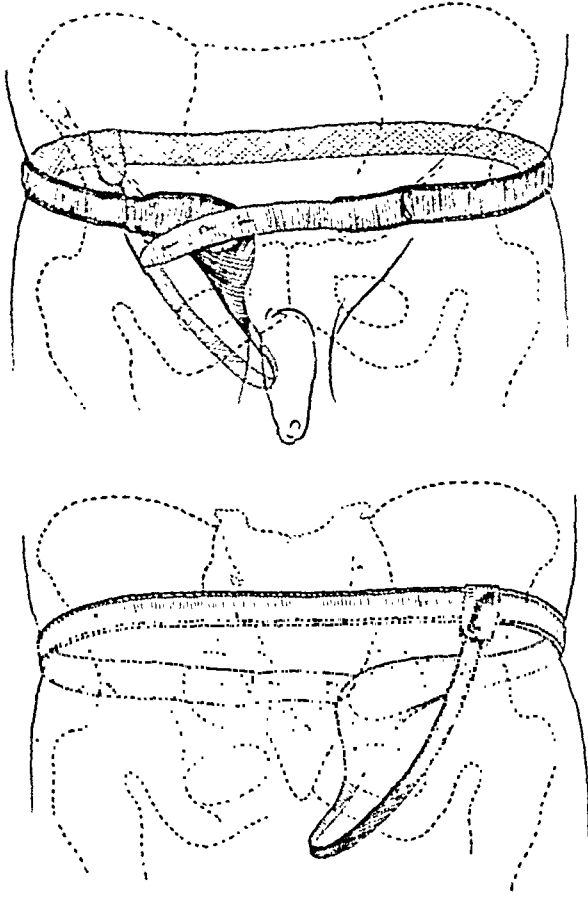


FIG. 23. Spring Truss, English or rat-tail type; front and back views.

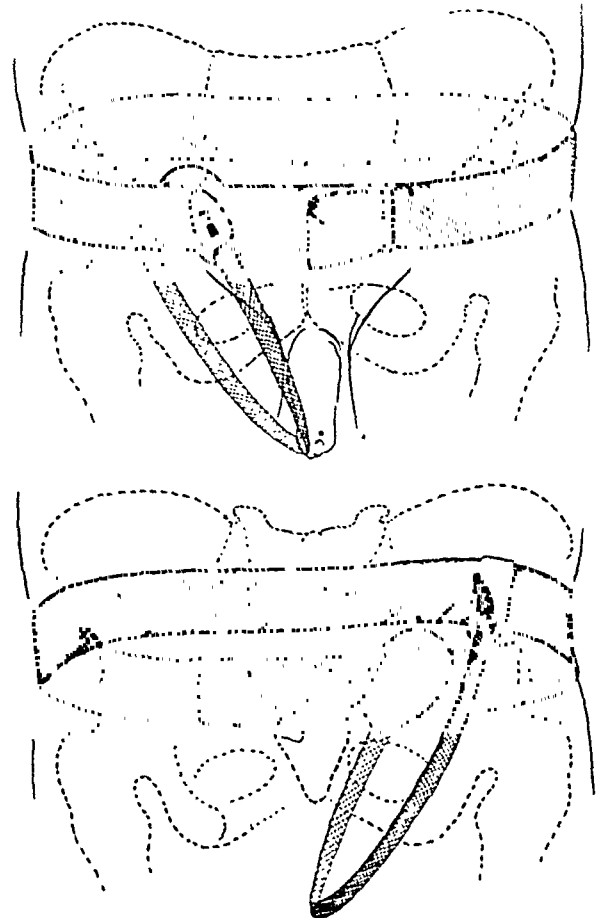


FIG. 24. Elastic Truss. See text for description.

pubic bone and may produce an atrophy of the testicle. For these reasons this type of truss must never be used in the injection treatment of hernia. Combinations of elastic and spring trusses have been advocated but their combination does not remove the disadvantages inherent in each. Any truss, whether spring or elastic, which depends on the inward pressure of an understrap for effect is unsatisfactory, since it causes an outward tilting of the upper portion of the pad. On any truss it may be occasionally advisable to place a very light understrap, merely to hold the truss down, as the patient moves in bed or otherwise grasps and moves the truss. The two leg strap functions must not be confused.

To recapitulate, then, for purposes of hernial reduction, in the injection treatment of hernia, the trusses of the semirigid

erally speaking they are somewhat less satisfactory than the semirigid type. Frame trusses with low counterpressure are satisfactory and for severe hernias are the truss of choice. Spring trusses should, as a rule, never be used since they fail to fulfill the function for which they were made. The English type of truss may occasionally prove to be satisfactory. Elastic trusses are entirely unsatisfactory and must never be considered. (See Table I for summary.)

A word must be said about the pads which are attached to the encircling band. These are made of various substances; hard rubber, factis, felt, wood and leather, but the best pad in our experience has been that made of sponge rubber. They are of various shapes; oval, round, triangular and elongated, but the most satisfactory appears to be an elongated oval pad with beveled

TABLE I

SUMMARY OF TYPES OF TRUSSES, WITH AN OUTLINE OF THEIR ADVANTAGES, DISADVANTAGES AND SUITABILITY FOR THE INJECTION TREATMENT

| Type of Truss | Variety of Truss   | Advantages  | Disadvantages   | Suitability for the Injection Treatment  |
|---------------|--|---|---|--|
| Semirigid     | Single strap (Figs. 6, 7, 8, 9)                                  | <ol style="list-style-type: none"> <li>1. The hernia is well held in reduction.</li> <li>2. Correct counterpressure.</li> <li>3. Correct relationship of pad to encircling band.</li> <li>4. Minimum of harness.</li> <li>5. Easily fastened and unfastened during injections.</li> <li>6. Can be slept in easily.</li> <li>7. Can be accurately adjusted for both direct and indirect types of hernias.</li> </ol>   | <ol style="list-style-type: none"> <li>1. An accurate knowledge of anatomy of the inguinal region is essential for fitting.</li> </ol>  | Adaptable for practically all hernias. Satisfactory for the injection treatment.   |
|               | Double strap (Figs. 10, 11, 12, 13)                              | <ol style="list-style-type: none"> <li>1. The hernia is well held in reduction.</li> <li>2. Correct counterpressure.</li> <li>3. Correct relationship of pad to encircling band.</li> <li>4. Easily fastened and unfastened during injections.</li> <li>5. Can be slept in easily.</li> <li>6. Can be accurately adjusted for both direct and indirect types of hernias.</li> </ol>   | <ol style="list-style-type: none"> <li>1. An accurate knowledge of anatomy of the inguinal region is essential for fitting.</li> </ol>  | Adaptable for practically all hernias. Satisfactory for the injection treatment.   |
| Rigid         | Simple frame (Fig. 14)   | <ol style="list-style-type: none"> <li>1. No great compression necessary for hernial reduction.</li> <li>2. Correct relationship of pad to encircling band.</li> <li>3. Posterior adjustments of straps and solid front frame prevents displacement of pads.</li> </ol>   | <ol style="list-style-type: none"> <li>1. Posterior counterpressure too high.</li> <li>2. Awkward to handle during injections.</li> <li>3. Easily becomes displaced during sleep.</li> <li>4. Requires skill in fitting.</li> </ol> | Adaptable for small hernias in certain individuals. Satisfactory for the injection treatment only in selected cases.                   |
|               | Short frame (Fig. 15)  | <ol style="list-style-type: none"> <li>1. No great compression necessary for hernial reduction.</li> <li>2. Correct relationship of pad to encircling band.</li> <li>3. Posterior adjustments of straps and solid front frame prevents displacement of pads.</li> <li>4. Can be slept in easily.</li> </ol>   | <ol style="list-style-type: none"> <li>1. Posterior counterpressure too high.</li> <li>2. Awkward to handle during injections.</li> <li>3. Requires skill in fitting.</li> </ol>  | Adaptable for small hernias in certain individuals. Satisfactory for the injection treatment only in selected cases.                   |
|               | Single strap with bilateral low counter pressure. (Fig. 16)      | <ol style="list-style-type: none"> <li>1. No great compression necessary for hernial reduction.</li> <li>2. Correct relationship of pad to encircling band.</li> <li>3. Posterior adjustments of straps and solid front frame prevents displacement of pads.</li> <li>4. Can be slept in easily.</li> <li>5. Correct posterior counter pressure.</li> </ol>   | <ol style="list-style-type: none"> <li>1. Requires skill in fitting.</li> <li>2. Awkward to handle during injections.</li> </ol>  | Adaptable for practically all hernias. Satisfactory for the injection treatment.   |
|               | Double strap with bilateral low counter pressure. (Figs. 17, 18) | <ol style="list-style-type: none"> <li>1. No great compression necessary for hernial reduction but an extremely great compression can be maintained for difficult hernias.</li> <li>2. Correct relationship of pad to encircling band.</li> <li>3. Posterior adjustments of straps and solid front frame prevents displacement of pads.</li> <li>4. Can be slept in easily.</li> <li>5. Correct posterior counter pressure.</li> <li>6. Double posterior strap prevents slipping of the truss.</li> <li>7. Can retain practically all hernias.</li> </ol> | <ol style="list-style-type: none"> <li>1. Awkward to handle during injection.</li> <li>2. Requires especial skill in fitting.</li> <li>3. Cumbersome for the patient to wear.</li> </ol>  | Adaptable for practically all hernias but much too powerful a truss to be used on small hernias. Suitable for the injection treatment. |

TABLE I (Continued)

| Type of Truss | Variety of Truss        | Advantages   | Disadvantages  | Suitability for the Injection Treatment                          |
|---------------|-------------------------|--|--|--|
| Spring        | Scrotal truss (Fig. 21) | 1. Can be fitted easily.   | 1. The truss spring is too short to give the necessary compression.<br>2. Incorrect relationship between pad and encircling band.<br>3. Posterior counterpressure is too high.<br>4. The truss is heavy and uncomfortable for the patient.<br>5. Can cause dangerous complications by giving pressure over the cord and pubic bone.<br>6. Fails to completely hold hernias in reduction. | Entirely unsatisfactory for the injection treatment.             |
|               | German truss (Fig. 19)  | 1. Can be fitted easily.   | Same as scrotal truss  | Entirely unsatisfactory for the injection treatment.             |
|               | French truss (Fig. 20)  | 1. Can be fitted easily.   | Same as scrotal truss  | Entirely unsatisfactory for the injection treatment.             |
|               | Chase truss (Fig. 22)   | 1. Can be fitted easily.   | Same as scrotal truss  | Entirely unsatisfactory for the injection treatment.             |
|               | English truss (Fig. 23) | 1. Can be fitted easily.<br>2. The spring is of sufficient length to give the necessary compression.<br>3. Correct relationship of pad to encircling band. | 1. Posterior counterpressure is too high.<br>2. Fails to hold in reduction a large majority of hernias.  | Satisfactory for the injection treatment only in selected cases. |
| Elastic       | All varieties (Fig. 24) | Requires no knowledge for fitting.   | 1. Greatest pressure is over hips, not over the inguinal canal.<br>2. Causes pressure over the spermatic cord and pubic bone.<br>3. Posterior counterpressure too high.<br>4. Anatomically unsound. Cannot be fitted accurately over the area of weakness.<br>5. Fails to retain practically all hernias.<br>6. Prolonged use results in an increase in the size of the hernia.          | Should never be used in the injection treatment.                 |

edges, anatomically fitted to the inguinal canal. For indirect hernias, the thickest portion of the pad should be over the internal ring, whereas in direct hernias, the thickest portion should be over Hesselbach's triangle. It is advisable to cover the pad with a layer of thin flannel to absorb moisture.

#### TRUSS FITTING AND THE DIFFERENTIAL DIAGNOSIS OF HERNIA

With the proper truss selected, the next consideration is its application to the given case. It is not the purpose of this article to give detailed instruction in the mechanics of truss fitting but rather to point out the broad principles on which truss fitting is based. The average surgeon has

neither the time nor inclination to handle the details of truss fitting personally, and these are best left to the trussmaker, who should work and cooperate with the surgeon. However, the responsibility for the proper placement of the truss remains with the operator, and it is upon the accurate diagnosis of the type of hernia present that this placement is made.

The question of the differential diagnosis of types of inguinal hernia is of utmost importance in the injection treatment of hernia for two reasons: (1) as it concerns the placement of the truss, and (2) as it concerns the placement of the injections. Neither too much time nor too much care can be given to this phase of the method.

In the examination of a patient for hernia, the first consideration is to determine the presence of a hernia. The differentiation between hernia and hydrocele, varicocele, femoral hernia, sarcoma of the testicle, and the other numerous tumor masses, which may occur in the inguinal region and scrotum, must be made. Following the determination of an inguinal hernia, the second consideration is the definite diagnosis of the type of hernia; either indirect, direct or a combination of both. Thirdly, the question of total or partial reducibility of the hernia must be decided. It is with these latter two that we are here concerned.

The differential diagnosis between an indirect and direct inguinal hernia can be definitely made by means of the following maneuvers. The patient is first examined in the upright position, and if a truss is being worn, this should of course be removed. It seems unnecessary to mention that the underclothing should likewise be removed, but it is surprising to find surgeons attempting the diagnosis of hernia with underclothing only partially removed, and constantly obscuring the view of the examiner. With the patient, then, in the upright position, a mass is usually seen presenting itself in the groin. An oblong mass extending from the internal ring, down the canal, is usually an indirect hernia, whereas an oval mass more toward the midline, away from the canal and cord, is more apt to be a direct hernia. Pressure made over the mass will indicate its reducibility in the standing position. It is not advisable during this maneuver to place the finger of the examining hand through the scrotum into the canal, since nothing is gained by this procedure, and considerable harm to the muscles and fascial layers may be done. The testicles and cords should be palpated, and accurate measurements taken for purposes of future reference.

The patient is then placed on a table in partial Trendelenburg position, and the contents of the sac allowed to drop back into the abdominal cavity. The index finger of the examining hand is then placed within

the inguinal canal by invaginating the skin of the scrotum with the palm of the hand down. The subsequent findings in an indirect inguinal hernia are as follows: As the examining finger passes through the external ring, the area of muscle weakness is found to extend laterally toward the internal ring. Superiorly may be found the frayed fibers of the external oblique muscle. Medially the thick well formed conjoint tendon is easily palpable as it is attached to the pubic bone. However, the pubic bone cannot be felt except as covered by muscular tissue. Laterally there is a considerably thinning of the inferior crus of the external ring, and posteriorly the firm transversalis fascia is palpable. On coughing the contents of the sac strike the superior and lateral portion of the examining finger.

In a direct hernia, the examining finger, upon passing through the external ring, immediately drops through the muscular and fascial weakness in Hesselbach's triangle. Superiorly may be felt the edge of the external oblique muscle. Laterally are felt the firm fibers of the external and internal oblique muscles as they form the inguinal ligament. Medially the conjoint tendon is noted to be extremely thin and in large hernias, may be entirely absent. The pubic bone is very easily palpable and strikes the finger as an uncovered bony structure. This we have designated as the "bare area" of the pubic spine pathognomic of direct inguinal hernia. Inferiorly the posterior wall is felt to be extremely weak, and the examining finger drops down easily into the fascial weakness of Hesselbach's triangle. On coughing, the impulse of the sac contents strike the examining finger at the inferior and medial margins of the finger.

By means of these findings, and those made with the patient in the upright position, a tentative differentiation can usually be made. As a further check, firm pressure is made over the internal ring, and with this pressure constantly maintained, the patient is allowed to get up from the table.

If on examination the hernia is still reduced, the examining fingers are removed and the hernia, which will be of the indirect inguinal type, allowed to descend. On the other hand, if the hernia is present in the standing position following this maneuver, with pressure still maintained over the internal ring, the hernia must be of the direct type, since it has descended despite pressure over the internal ring. This maneuver may be repeated with pressure exerted over Hesselbach's triangle as an additional check on a possible direct hernia. In a certain percentage of cases the hernia will be of the saddle-bag variety, and there will be both a direct and indirect element. By means of the described maneuvers, this fact can be ascertained.

In addition to these procedures there is one more aid in the differential diagnosis which is not commonly known. In the male the inguinal ligament varies in length from 9 to 19 cm. Careful check-up on 300 cases has shown that when a hernia is present in a patient whose inguinal ligament measures less than 15 cm. it is always of the indirect type; and conversely when the inguinal ligament measures more than 15 cm. the hernia is always of the direct type. It has likewise been noted that the length of the penis varies inversely with the length of the inguinal ligament. In other words, in those patients with relatively short inguinal ligaments, the external genitalia are relatively large, and will measure upwards of 7 cm., and in those patients with long inguinal ligaments the penis will measure less than 7 cm. It follows that the indirect type of inguinal hernia will always occur in patients with relatively large genitalia, and that the direct type will occur in those with smaller genitalia. The reasons for these findings are obscure, but a logical explanation would be that a long inguinal ligament would require a great deal of fascia for its formation, leaving less available for Hesselbach's triangle and the external genitalia, and would thus predispose to a direct inguinal hernia. On the other

hand, a short inguinal ligament would leave a great deal of fascia available for Hesselbach's triangle and the external genitalia, and the only possible type of hernia which could develop would be an indirect hernia, due to a congenital defect in the development of the descending testicle.

It may be mentioned at this point that these diagnostic maneuvers will reveal a much higher percentage of direct inguinal hernias than the incidence which is given in most textbooks. These claim an incidence of 6 to 8 per cent of direct hernias, whereas in our series 31 per cent have been of the direct type. This includes cases of simple direct, direct hernias associated with indirect hernias of the saddle-bag type, and recurrent postoperative direct hernias.

With the accurate diagnosis of the type of hernia made, its reducibility remains to be determined. The question of reducibility is especially important since non-reducible hernias cannot be treated by the injection method. The reducibility of the hernia can be best made out with the patient lying in the Trendelenburg position. Careful palpation along the inguinal canal, or in the region of Hesselbach's triangle, will reveal the presence of any irreducible sac contents. These must be differentiated from the thickened walls of a large hernial sac, which may be entirely empty, from thickened structures of the cord, and from a tag of peritoneal fat which may be attached to the outside of the neck of the sac. In a number of cases, a small tag of omentum caught within the sac may show very little of a demonstrable mass, but merely give an obliteration of some of the details of muscle and fascia position which would ordinarily be found. With these things in mind, however, the reducibility of a hernia can usually be decided definitely. In those cases in which there is any question, or in which there is any difficulty in affecting reduction, it is not advisable to so manipulate the hernial sac contents as to cause damage to tissue. It must be rea-



lized that these cases are not amenable to cure by the injection method, but must be treated by the accepted surgical procedures.

#### APPLICATION OF TRUSS TO PATIENT

Assuming that by means of these diagnostic procedures an accurate diagnosis has been made and with the consideration of the proper type of truss in mind, the actual fitting of a truss to the given case may proceed. Following the first application of the truss by the trussmaker it is advisable that the patient report to the surgeon for check-up as to its position and effectiveness. It will be found that in most cases, several or more adjustments of the truss will be necessary during the first week or two, to insure complete retention of the hernia at all times.

For the purposes of treatment the truss must be worn day and night for a period of six to eight weeks, and before treatment is started it is imperative that the patient be able to keep the truss on constantly. In some patients, particularly children and adults of blond complexion, it will be impossible to keep a truss on continuously at first since the tenderness of the skin predisposes to blisters and excoriation under the truss. In these patients it will be necessary to begin the truss wearing for a few hours each day, gradually increasing the time until it is being worn continuously. Under no circumstances should the injection treatment be begun until the patient has been able to wear the truss day and night for one week, without protrusion of the contents of the hernial sac.

It is advisable during the period of truss adjustment to bathe the area underneath the truss pad daily with soap and warm water, and to massage the area gently with alcohol thereafter. The application of the following dusting powder is helpful.

|                             |    |   |
|-----------------------------|----|---|
| R <sub>y</sub>              |    |   |
| Ammoniated mercury (powder) |    | 3 |
| Zinc oxide                  | 8  |   |
| Zinc carbonate              | 8  |   |
| Boric acid                  | 1  |   |
| Powdered talc q.s.          | 30 |   |
| M. Sig.: Apply locally      |    |   |

If there is considerable redness and swelling of the skin, application of hot or cold compresses for a period of thirty minutes daily are soothing, and will relieve the inflammation. Once the truss is worn continuously the question of bathing becomes important to the patient. The search has been long for a true waterproof truss but up to the present time no satisfactory waterproof truss has been placed on the market. Various efforts to take care of this difficulty have resulted in different types of trusses; the first is that made of steel, of the semi-frame type, with a complete covering of rubber. The truss is sturdily made and extremely satisfactory as far as holding the hernia is concerned; however, the continuous wearing of a rubber truss tends to irritate the skin by causing a considerable perspiration between the skin and the truss which cannot be absorbed. The patients complain of burning and itching, especially underneath the strap, which encircles the body. A second attempt at waterproof trusses has been made by saturating the leather covered truss in paraffin. In cooler climates this truss will remain waterproof for up to two years; however, in warm climates the heat tends to melt the paraffin and the truss remains satisfactory only for about two to three months. A satisfactory arrangement is for the patient to construct a rubber apron which may be fitted over the truss and worn as a shower is taken. However, most patients will have to be content with sponge baths.

#### CONCLUSION AND SUMMARY

With an understanding of the considerations outlined, the injection treatment can be an effective method for the cure of inguinal hernia. Accuracy in the diagnosis of the various types of inguinal hernia, care in the selection of the proper kinds of trusses, and cooperation between the surgeon, trussmaker and patient in the fitting of the truss, will insure the maximum success with this therapeutic procedure.

1. The importance of trusses in the injection treatment of hernia, and the general

ignorance and misinformation of the profession in this regard, make scientific study of this problem imperative.

2. The anatomy of inguinal hernias must be understood in its relationship to the application of trusses.

3. The important factors in consideration of a truss for hernia are first, its accurate placement over the internal ring, in an indirect hernia, and over Hesselbach's triangle in a direct hernia; second, the necessity of pressure through the inguinal canal at right angles to the pad; and third, the need for alinement of the truss pad and the encircling band.

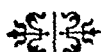
4. The failure to adhere to these essential principles, which are based on the anatomical structure of the inguinal region, results in danger to the patient and failure of the injection treatment.

5. The various types of trusses are analyzed and their advantages and disadvantages evaluated.

6. The importance of differential diagnosis between direct and indirect types of inguinal hernias, in the application of a truss, is stressed. The diagnostic importance of the "bare area" on the pubic spine in direct hernias is emphasized. Newer conceptions in the differential diagnosis show definite relationships between the length of the inguinal ligament and the occurrence of direct and indirect types of hernia.

7. With an understanding of these factors the application of the truss to a given case is discussed.

8. A detailed observance of the principles outlined will insure satisfactory results in the injection treatment of hernia.



PATHOGENIC microbes are the one constant causative agent in all cases of puerperal fever. There is no such case as aseptic thrombophlebitis, or aseptic febrile conditions in the puerperium. Any organism that can produce a morbid state in a surgical wound may become the agent of puerperal infection. Puerperal infection is surgical wound infection.

Puerperal Infection by James Robert Goodall, M.D.

# FOREIGN BODIES IN TRACHEOBRONCHIAL TREE

## OBSERVATIONS AND REVIEW OF 30 CONSECUTIVE CASES

MORRIS S. BENDER, M.D.

AND

MAX L. SOM, M.D.

Associate Laryngologist, Mt. Sinai Hospital,  
New York; Director, Department of  
Otolaryngology, Queens General  
Hospital, Jamaica, N. Y.

Adjunct Laryngologist, Mt. Sinai Hospital;  
Adjunct Endoscopist, Montefiore Hospital;  
Assistant Visiting Otolaryngologist,  
Queens General Hospital

NEW YORK CITY

FOREIGN bodies in the air passages occur with relative frequency, their incidence, of course, cannot be tabulated, but it is sufficient to state that these preventable accidents may happen at any age.

Beginning with the newborn who may aspirate meconium or regurgitated food, to the adult who accidentally chokes on his food, the aspiration of foreign bodies into the tracheobronchial tree are in the main, avoidable accidents. The foreign body, in itself, is not dangerous, except when completely obstructing the larynx or the trachea, thereby causing obstructive asphyxia. Here, of course, immediate removal of the foreign body is a life-saving measure. Most foreign bodies that lodge in the tracheobronchial tree produce secondary bronchopulmonary disease. It is these pulmonary complications and their sequels that may end disastrously.

The foreign bodies are of three classes; animal, vegetal and mineral matter. Since the advent of bronchoscopy and roentgenography, there is no reasonable excuse for any foreign body remaining lodged in the lung longer than it takes to determine its location and preparation for its extraction. In recent years, this matter has been called to the attention of the profession and the layman with sufficient frequency to make one suspicious, at least as a possibility, in all obscure pulmonary diseases. One might almost make it an axiom, that in a previously healthy person, who gives a history of sudden paroxysms of coughing, dyspnea, cyanosis, asthmatic breathing, and in late cases, hemoptysis,

fever, and chest pains, that cannot be explained on the basis of a definite disease entity, foreign body should be suspected. This is likewise true in those cases of atypical suppurative pneumonias, particularly in children.

In all lung abscesses, unless a definite etiological factor is found, suspect possible foreign body, and rule it out. It should be remembered that the x-ray will not always identify a foreign body, unless it is radio-opaque. Metallic objects and animal matter, such as bones are usually easily defined. Occasionally bones, unless of sufficient density, may not show a defined shadow, because as is frequently the case, the shadow may be obscured by a dense infiltration of lung tissue. The bronchoscope is the instrument of choice to eliminate conclusively the possibility of foreign body or to establish its presence.

There is practically no contraindication to bronchoscopy when it is to be used for extraction of foreign bodies.

The x-ray is a most valuable adjunct and should be used before bronchoscopy is undertaken, to locate the probable site of the foreign body so that the bronchoscopic procedure is shortened. When a non-opaque body is the offending agent, a roentgenogram will show, in many instances, a classical picture which results from obstructive emphysema or atelectasis. The simple use of the stethoscope will frequently help to establish the diagnosis, particularly if there are signs of an obstructive bronchial lesion.

Almost all foreign bodies in the tracheobronchial tree can be removed endoscopi-

cally, and, it may be said, with complete safety to the patient. The prospects of full recovery are excellent, provided that the foreign body is removed within a reasonable time after aspiration. In other words, the sooner the foreign body is removed from the air passages, the better the prognosis for recovery.

We are reporting 30 cases of foreign bodies aspirated into the tracheobronchial tree, observed during the past five years on the Laryngological Service at the Mt. Sinai Hospital. Of the total, 13 were bones, 8 metallic and 9 vegetal bodies.

The vegetal group gave prompt signs and symptoms of bronchial inflammation. This prompt reaction is due to the irritation by the fixed oils present in vegetable matter, and early draws attention to the probable diagnosis. In this group, the longest period of the offending body present in the lung was fourteen days before removal.

Of the remaining 21 cases, the metallic and bone group, the diagnosis was not established in 9 instances for a period ranging from nine weeks to ten years.

The foreign bodies were removed endoscopically in all 30 cases. Complication resulted only in those instances where the diagnosis of a foreign body was not made within nine weeks.

On analysis, the age group is as follows:

| Age in Years   | No. Cases |
|----------------|-----------|
| 1 or less..... | 5         |
| 2 to 10.....   | 8         |
| 21 to 30.....  | 3         |
| 31 to 40.....  | 4         |
| 41 to 50.....  | 2         |
| 51 to 60.....  | 6         |
| 61 to 70.....  | 2         |

The foreign bodies are as follows:

Bony substances: 7 meat and 4 chicken bones, and 2 incisor teeth.

Metallic substances: 1 straight pin, 1 paper clip, 1 screw, 2 gold tooth crowns, 1 gold inlay, 1 safety pin, and 1 upholsterer's tack.

Vegetal bodies: 3 peanut kernels, 1 indian nut kernel, 1 pistachio nut shell,

1 pecan nut shell, 1 watermelon seed, 1 pumpkin seed, and 1 squash seed.

#### ABSTRACTS OF CASES

CASE I. Adult, aged twenty-nine years; meat bone in right lower lobe bronchus present one day. X-ray picture negative.

CASE II. Child, aged three years; watermelon seed present five days. X-ray film negative.

CASE III. Adult, aged thirty-eight years; chicken bone in right lower lobe bronchus present eleven weeks. Choked on eating chicken. Five days later developed fever, grippe, unresolved pneumonia. X-ray plate showed infiltration of the right lower lobe. On bronchoscopy a flat bone 6 by 12 mm. was completely occluding the right lower lobe bronchus; foul pus was present. Lipiodol bronchogram showed bronchiectasis. He was rebronchoscoped because of a flare up after upper respiratory infection. His recovery was complete.

CASE IV. Adult, aged twenty-eight years; one-half a squash seed present ten days giving symptoms of paroxysmal cough; followed by recovery.

CASE V. Adult, aged fifty-nine years; bone in the left lower lobe bronchus present seven months, causing recurrent episodes of cough, fever, foul sputum and hemoptysis. A clinical diagnosis of carcinoma of the lung was made. X-ray films showed infiltration of the left lower lobe with a foreign body. Lipiodol injection showed a bronchiectasis with atelectasis. He was symptom free after two months.

CASE VI. Child, aged eight years; paper clip in the right main bronchus present four days. X-ray revealed a partial atelectasis of the right middle and lower lobe. Recovered.

CASE VII. Adult, aged fifty-eight years; bone in right main bronchus present two years, causing a cough for two years, chest pain, hemoptysis and loss of weight. X-ray showed atelectasis of the right lower lobe. On bronchoscopy a bone was removed from the right lower lobe bronchus, following which the lung became aerated. He was symptom free, although lipiodol bronchogram showed a cylindrical dilatation of the right lower lobe bronchi.

CASE VIII. Adult, aged forty-eight years; gold tooth crown in the right lower lobe bronchus present twenty-five days. He aspirated the tooth crown and began to cough

seven days later. X-ray revealed a foreign body. The crown was removed; pus was found in all the branches of the right lower lobe bronchus. Recovered.

CASE IX. Child, aged two and one-half years; metal screw in the right lower lobe present two hours. X-ray showed a foreign body. Patient recovered.

CASE X. Adult, aged thirty-six years; meat bone (pig's knuckle) in the right lower lobe present nine weeks giving him pain in the right chest, fever and cough; diagnosed as pneumonia, right lower lobe; x-ray pictures showed consolidation of the right lower lobe with a dense shadow within the consolidated area. On bronchoscopy a large amount of non-foul pus was present in the right lower lobe. The bone was removed. He developed pleural infection which proved to be an anaerobic infection of pleura for which a thoracotomy was done. He died from this wound infection and sepsis.

CASE XI. Adult, aged sixty-eight years; gold inlay in right main bronchus present two hours. X-ray plate showed the foreign body.

CASE XII. Adult, aged thirty-seven years; upholsterer's tack in the left lower lobe bronchus present ten years. He gave a history of small hemoptyses for a few years. Nine weeks prior to hospitalization, he developed bronchopneumonia of the left lower lobe complicated by emphysema. Operation was done for multilobar putrid lung abscess. Following the operation the patient remembered aspirating the tack. Bronchoscopy revealed stenosis of left lower lobe bronchus, and the tack removed. The patient died from a metastatic brain abscess.

CASE XIII. Adult, aged fifty-two years; chicken bone in right lower lobe present one year, causing paroxysmal cough for one year, associated with wheezing. He was more comfortable when sleeping on his right side. The foreign body was removed on the second bronchoscopy. There was bleeding from the granulations, and bronchoscopy was repeated because of persistent bronchiectasis.

CASE XIV. Adult, aged thirty-three years; incisor tooth in left lower lobe present one and one-half years, and was previously diagnosed as pulmonary tuberculosis. The tooth removed followed by recovery.

CASE XV. Adult, aged twenty-three years; chicken bone in the right lower lobe present

twenty months. X-ray pictures showed consolidation of the left lower lobe with bronchiectasis. He had rheumatic heart disease, foul sputum, hemoptysis four months after aspiration of the foreign body, fever and pain in chest. He died of pneumonia.

CASE XVI. Adult, aged fifty-seven years; chicken bone in the right main bronchus present one week. X-ray showed a foreign body.

CASE XVII. Child, aged twenty months; peanut kernel in the right main bronchus present twenty hours producing symptoms of dyspnea and cyanosis. X-ray picture showed increased aeration of the right lung with widening of the intercostal spaces. A diagnosis of ball-valve foreign body was made. On bronchoscopy the peanut was removed.

CASE XVIII. Child, aged six years; a bone in the right lower lobe present one year. X-ray picture showed atelectasis of the right lower lobe. Bronchoscopy revealed purulent infection with exuberant granulations of the right lower lobe. The bone was removed but bronchiectasis persisted.

CASE XIX. Adult, aged fifty-two years, bone in right lower lobe bronchus present one year. X-ray film showed infiltration of the right lower lobe with a pleural thickening. Bronchoscopy revealed bleeding granulations with pus in the right lower lobe. The bone was removed on second bronchoscopy. Lipiodol injection showed saccular bronchial dilatation of the right lower lobe.

CASE XX. Child, aged ten years; pumpkin seed in the right lower lobe present three days. Bronchopneumonia developed but the child recovered.

CASE XXI. Child, aged sixteen months; open safety pin with the point up in the trachea present two hours. X-ray picture showed the pin. Following extraction the child developed an upper respiratory infection but recovered.

CASE XXII. Child, aged nine years; pistachio nut shell transfixing in anterior-posterior subglottic region present ten days. Symptoms presented an inspiratory and expiratory stridor. There was a low grade fever and some swelling of the anterior tracheal wall. The shell was extracted and was followed by an uneventful recovery.

CASE XXIII. Adult, aged sixty-two years; meat bone present one day, with symptoms of

cough, and a marked subcutaneous hemorrhage of the face due to violent coughing. Patient at first refused medical care, then returned and consented to bronchoscopy when the bone was removed and followed by recovery.

CASE XXIV. Child, aged seven and one-half years; indian nut in the right main bronchus present two weeks with symptoms of chills and fever. X-ray pictures showed a pneumonia of the right lower lobe. Bronchoscopy revealed a stenosis of the right main bronchus. The pneumonia cleared up after the extraction of the foreign body.

CASE XXV. Child, aged two years; straight pin in right lower lobe present eight days. X-ray showed the pin head down in the right lower lobe. Eleven hours after aspiration, the first attempt at another hospital failed to remove the pin. Eight days later, with combined bronchoscopy and fluoroscopy, the pin was removed and the patient recovered.

CASE XXVI. Child, aged eight months; pecan nut shell lodged in trachea, present twenty-four hours.

CASE XXVII. Child, aged two and one-half years; peanut kernel in the right main bronchus present five days. X-ray picture showed an obstructive emphysema of the right chest.

CASE XXVIII. Adult, aged fifty years; incisor tooth in the right lower lobe present ten days. While intoxicated he fell down stairs and lost a tooth and was followed by symptoms of incessant coughing. Bronchoscopy revealed a narrowing of the right lower lobe bronchus. The patient recovered.

CASE XXIX. Adult, aged twenty-eight years; gold tooth crown in trachea above bifurcation present twenty-four hours, producing symptoms of persistent cough for twenty-four

hours. On bronchoscopy the artificial gold tooth with a small piece of vulcanite casing attached was removed. The patient recovered.

CASE XXX. Child, aged two and one-half years; peanut kernel in the right main bronchus present twenty-four hours, causing symptoms of persistent cough. X-ray showed slight emphysema of the right lung. The patient recovered.

#### DEATHS

There were 3 deaths in this series of 30 cases. A brief summary of each case follows.

CASE XV. The patient had rheumatic heart disease; a bone in the bronchus for twenty months complicated by bronchiectasis with a dilatation of pulmonary vessels. His death was accidental, due to instrumentation.

CASE X. Foreign body, bone in bronchus for nine weeks. The patient developed suppurative bronchiectasis with a lung abscess, and death was due to pleural infection.

CASE XII. Upholsterer's tack in left lower lobe bronchus for ten years, complicated by putrid lung abscess and emphysema. Operation done and multilocular putrid lung abscess found. Death was due to a metastatic brain abscess.

#### SUMMARY

A series of 30 cases of foreign bodies in the tracheobronchial tree are reviewed. Pulmonary suppuration does result from prolonged bronchial obstruction. Fatalities occurred in 3 cases. Immediate complications were not observed. Tracheotomy was not necessary in this group.



# INSERTION OF SMITH-PETERSEN NAIL FOR INTRACAPSULAR FRACTURES OF NECK OF FEMUR\*

J. ALBERT KEY, M.D.

ST. LOUIS, MO.

SINCE its introduction by Smith-Petersen<sup>1</sup> in 1931, the three-flanged nail has been widely recognized as a most efficient method of fixing two fragments of cancellous bone together and its application to intracapsular fractures of the femur has been practiced in surgical centers in various parts of the world.

The chief objection to the procedure is that its introduction under direct vision by means of a complete exposure of the hip is a formidable procedure, especially when applied to senile and debilitated patients. Consequently, numerous methods of avoiding this large operation have been suggested and practiced. For instance, O'Meara<sup>2</sup> introduces the nail blindly and has done so successfully through a small lateral incision. However, this method presupposes considerable accuracy on the part of the surgeon and for that reason has not been generally adopted. Wescott,<sup>3</sup> Bunnell<sup>4</sup> and others have used mathematical projection apparatus for directing the nail. These methods also are difficult to apply and have not been generally adopted. Johansson,<sup>5</sup> King,<sup>6</sup> Carrell<sup>7</sup> and others have had their nails drilled through the center or head and have first inserted one or more Kirschner wires and then, after checking the position of the wires with the radiograph, have threaded the nail on the wire which has been found to be in a satisfactory position and driven it into the head of the femur and have then withdrawn the wire. This method is probably the best method yet devised. The chief objections are that it is difficult to obtain the Smith-Petersen nails made of a solid piece of stainless steel which have a canal drilled through the center for the passage of the wire, and that several

instances have been reported in which the wire has become bent or kinked or has been forced into the pelvis while the nail was being driven home. In such instances difficulty has been encountered in removing the wire.

I wish to report a method which I have used which requires less special apparatus and which appears to be one which can be used without difficulty by the average orthopedic surgeon. It differs from the blind nailing or from the nailing with projection apparatus in that a drill is first passed through the neck and into the head of the femur and the position of this drill is checked by roentgenograms. Then, using the drill as a guide, the drill is pulled out and the nail is driven home. This method is applicable to all intracapsular fractures of the neck of the femur in which the patient is believed to be in a condition to stand a moderate surgical procedure. I think that it should be done as soon after the accident as practicable. However, if the patient is in shock he should be put to bed with the leg in traction (about ten pounds) with the knee and hip slightly flexed and slightly abducted until the condition has improved sufficiently to justify proceeding with the reduction and nailing. This may take a few days or, of course, the patient may not improve sufficiently to warrant interference. The method is especially valuable in cardiac patients who have difficulty in remaining recumbent as they may be propped up in bed immediately after the operation.

The Smith-Petersen nail is used in fractures which are believed to be impacted because the method enables these patients to be gotten up soon after the operation. It is to be remembered, how-

\* From the Department of Surgery of the Washington University School of Medicine, St. Louis, Missouri.

ever, that when the nail is driven into the head the impaction is broken up and the head and neck are separated and the fragments must be re-impacted.

follows: While an assistant fixes the pelvis by pressing downward upon the anterior superior spines, the surgeon flexes the hip and knee of the fractured leg to slightly

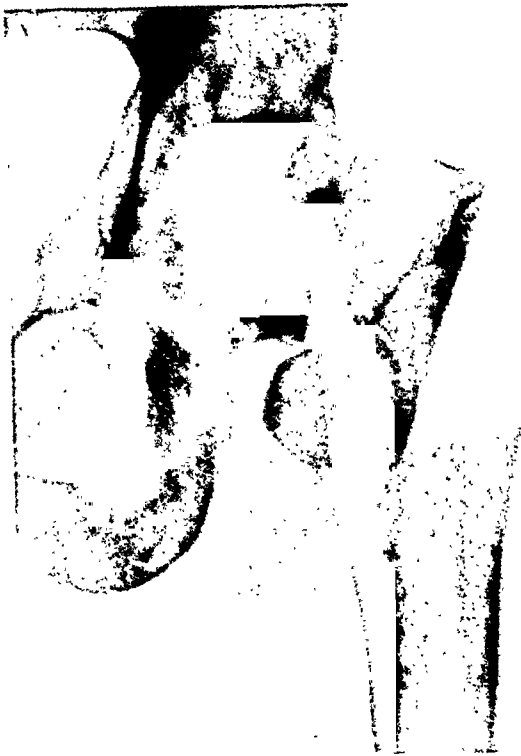


FIG. 1. Fracture through the neck of the femur before and after nailing. Note that the fracture is slightly over-reduced in that the head tends to sit on top of the neck in the valgus position.

#### TECHNIQUE OF PROCEDURE

**Anesthesia.** I have used avertin or morphine and local anesthesia. The patient is given a relatively small dose of avertin (65 to 70 mgm. per kilo.) or  $\frac{1}{4}$  grain of morphine. About 10 c.c., of 1 per cent novocain is then injected into the hip joint. The injection is made by inserting the needle vertically to the surface at a point about 1 inch below Poupart's ligament and 1 inch lateral to the femoral artery. The needle can be felt to slip through the distended capsule and some sanguinous fluid can be aspirated when the point of the needle is in the joint.

**Reduction.** The patient is then placed upon a fracture table and the sound limb is fixed to the traction apparatus in full abduction without undue tension and with just enough traction to hold the patient against the perineal post. The hip is then reduced by the Leadbetter method as

beyond a right angle and, while maintaining it in a position of slight external rotation and slight adduction with moderate traction upward in the long axis of the femur, has a second assistant pull outward and downward on the upper portion of the thigh, thus tending to unlock the fragments and to stretch the capsule around them. The surgeon maintains the axial traction and circumducts the hip outward and downward, at the same time internally rotating it, thus bringing it downward to a position level with the table in moderate abduction and internally rotated to about 30 degrees. Leadbetter's heel-palm test is then applied; that is, if the reduction has been successful it will be possible to maintain the limb in a position of internal rotation by simply resting the heel of the abducted leg on the surgeon's palm. If the reduction has not been successful, as soon as the foot is released the extremity will roll outward into external rotation.



If this occurs the reduction is repeated until the Leadbetter test is positive. The foot on the fractured side is then fixed

rotation and moderate abduction, the abduction being maintained without undue tension and just enough traction being applied to hold the pelvis firmly against the perineal post.

*First X-ray Picture.* At this point anteroposterior and lateral x-ray pictures are taken. We have used the curved cassette for the lateral x-rays. However, any method which gives a satisfactory lateral x-ray may be used, but I think it important that the patient should not be moved again until the nail has been driven home.

*Preparation of Patient and Local Anesthesia.* While the x-ray films are being developed the surgeon scrubs up and the operative field is prepared by an assistant and the patient is draped. The skin and subcutaneous tissues down to and including the periosteum over the lateral border of the femur from just above the trochanter downward a distance of about 8" are anesthetized with novocain (1 per cent for the skin and  $\frac{1}{2}$  per cent for the deeper tissues and containing 3 drops adrenalin to the ounce). The first x-ray films are developed by the time the surgeon is ready to begin the operation. Then, if the reduction is satisfactory, the operation is begun. If not, the reduction is repeated.

*Operation.* An incision about 6 inches long is made over the lateral surface of the femur, the upper end being at about the tip of the trochanter and extending straight downward along the lateral border of the thigh. This incision is carried down to the bone and through it the tip of the trochanter can be felt. Then, from the x-ray film this distance can be roughly measured on the outer border of the femur to reach a point from which a nail or drill inserted through the outer cortex, being directed parallel to the neck of the femur, will penetrate the center of the head. This point is about  $\frac{1}{2}$  inch below the base of the greater trochanter. The drill is then inserted at this point parallel with the table and directed upward at an angle corresponding roughly with that of the axis of the neck of the femur. I use an ordinary



FIG. 2. Same hip. Above, showing reduction; middle, showing drill in position, the drill being too near the lower border of the head; lower, showing nail driven at a slightly different angle to approach the center of the head.

to the traction apparatus of the table in a position of about 45 degrees of internal

ve it just a little more angulated. I think is necessary, because my to put it too near a right angle shaft of the femur. The drill about 3 inches and is left in situ. X-ray Pictures. The field is covered with a sterile sheet and anterior and lateral x-ray pictures made. It is necessary to wait until callus are developed before proceeding

*of the Nail.* From the position of the hip the length of the nail desired for the articular hip is selected. It is not necessary that the drill be driven to the cartilaginous margin of the head, as due allowance can be made for penetration. Likewise, if the drill has been driven through the head of the acetabulum, as may occur, one can make for this. If the drill is in the coronoid—that is, extends down the neck, preferably just below the neck—it is pulled out, and it slips out with the fingers, and the nail is driven along the drill hole. If, however, it is found that the drill is too high or is pointed a little too much up or toward the head or foot of the femur, or if it is pointed forward or backward a little too much, then the nail is driven in parallel with the drill hole, in a direction that it will reach the center of the head of the

surgeon has difficulty in fixing the direction of the drill during the interval when it is pulled out and the nail is started, then one can drive a nail or insert a small drill into the femur about an inch above or an inch below the drill while the drill is in place, and guide while the Smith-Petersen nail is driven parallel to this guide. It has not been found to be in the desired position, then the guide acts as a line from



FIG. 3. Same hip, lateral view. Upper, showing reduction; middle, showing the drill in position, slightly more forward than desirable; lower, showing nail driven at a slightly different angle from the drill to approach the center of the head.

sary. All that is necessary is to get it through the neck and firmly into the head of the femur. After the nail has been driven home the distal fragment is firmly impacted upon the head. For this the Smith-Petersen impactor is desirable, but if this is not at hand, a short length of  $\frac{1}{2}$  inch metal pipe or the handle of a hammer or large chisel may be used.

*Third X-ray Pictures.* The field is again covered with a sheet and anteroposterior and lateral x-rays are made with the nail

FIG. 4



FIG. 5

FIG. 4. Fracture through the neck of the femur six weeks after nailing. Note the slight under-reduction; that is, the head is in a slight varus position.  
FIG. 5. Same hip as in Figure 4 ten months after operation.

driven home and the fragments impacted. While these are being developed the sur-

geon proceeds to close the wound, but asepsis is maintained until the final x-ray films have been inspected, because if the final x-rays are not satisfactory the wound can be opened and the nail extracted and reinserted if necessary. After the wound is closed and the dressing applied the extremity may be placed in a Thomas splint with the knee and hip slightly flexed and the hip slightly abducted or the patient may be put to bed with or without fixation of the extremity.

In my first cases I left the Thomas splint on for from two to four weeks. At the end of this time the splint was removed and the patient was gradually gotten up on crutches. In more recent cases I have not immobilized the leg after the operation. At the end of a month I think it is well to let the patient begin to bear some weight upon the leg, but believe that the crutches should be continued until at least three months after the operation and that the nail should remain in for a year unless it gives trouble. If the nail does not give any trouble I do not see any necessity for removing it at all.

A word should be said in regard to the reduction. It is not my belief that an anatomical reduction is necessary or even desirable. I prefer a slight over-reduction of the fracture; that is, I would rather have the distal fragment displaced slightly downward so that the head tends to sit on the top of the neck, thus producing a slight coxa valga. This, I believe, permits more thorough impaction than does an anatomical reduction and gives a better chance of union, because it tends to lessen the shearing force at the site of the fracture. Such a reduction is illustrated in the patient shown in Figures 1 to 3 inclusive. This is not necessary, however, as shown in Figures 4 and 5. In this instance the distal fragment is displaced slightly upward; yet this patient has obtained union and apparently had a normal hip five months after the operation, walking without a limp and going up or down stairs in the normal manner.

## SUMMARY

As a guide for the insertion of a Smith-Petersen nail in intracapsular fractures of the femur, the author first inserts a  $\frac{3}{16}$  of an inch twist drill. This gives the direction as well as the length of nail desired.

The technique of the operation is described in detail.

## REFERENCES

1. SMITH-PETERSEN, M. N., CAVE, E. F. and VAN GORDER, G. W. Intracapsular fractures of the neck of the femur: treatment by internal fixation. *Arch. Surg.*, 23: 715, 1931.
2. O'MEARA, J. Fractures of the femoral neck treated by blind nailing. *New England Jour. Med.*, 212: 43, 1935.
3. WESCOTT, H. H. A method for the internal fixation of transcervical fractures of the femur. *Jour. Bone and Joint Surg.*, 16: 372, 1934.
4. BUNNELL, S. Fracture of the neck of the femur: slide for accurately directing dowel peg. *Surg., Gynec., and Obst.*, 57: 658, 1933.
5. JOHANSSON, S. An operative treatment of fractura colli femoris. *Acta Orthop. Scandinav.*, 1932, page 362. Quoted by King, T. *Med. Jour. Australia*, 2: 521, 1935.
6. KING, T. Extra-articular osteosynthesis for recent fractures of the neck of the femur: a discussion of the technique and a report of personal experiences. *Med. Jour. Australia*, 2: 521, 1935.
7. CARRELL, W. B. A report on application of Smith-Petersen nail in fresh fractures of the femoral neck by adaption of a simplified technic. *Southern Med. Jour.*, 28: 583, 1935.



THE number of deaths from abortion is only in part available from the Census Bureau. The interesting and accurate study of maternal mortality conducted by the Children's Bureau . . . comprises material in thirteen states for the year 1927, and for these same states and two others in 1928. There were 1824 deaths in these two years due to abortion, or 912 a year. Since these states comprised 26 per cent of the Birth Registration Area of the United States we have 3508 abortion deaths annually in the United States. This number must be corrected by the addition of abortion deaths reported to the coroner and classified as homicides (approximately 5 per cent); and by the fact that the area covered in the Children's Bureau survey is 36 per cent urban and 64 per cent rural compared with the general average for the United States of 42 per cent urban and 58 per cent rural. These two corrections would bring the recorded abortion deaths for the entire country to not less than 4000.

Abortion by Frederick J. Taussig, M.D.

# LOCAL APPLICATION OF COD-LIVER OIL IN SKIN ULCERATIONS\*

ERVIN EPSTEIN, M.D.

LOS ANGELES, CALIF.

THE therapy of wounds, ulcers and burns by the local application of preparations of high vitamin content has been developed in Europe during the last few years. Most reports to date have emanated from Germany<sup>1</sup> while a few have appeared in the French<sup>2</sup> and English<sup>3</sup> literature. Despite the fact that the results obtained by these workers have been encouraging, little has been written in the journals of this nation. For this reason, this series of 31 cases is being recorded. Although, a group as small as this is insufficient to establish a therapeutic agent, the results were so unencouraging, that it was deemed inadvisable to continue this study.

## TECHNIQUE

All types of skin ulceration, with the exception of malignant and luetic lesions, were accepted for treatment. Other measures were obviously indicated in these two exceptions although cod-liver oil and anhydrous lanolin dressings were occasionally used in conjunction with the indicated injection or surgical therapy.

In most instances the patient was hospitalized but a small number were treated while ambulatory. The only auxiliary therapy employed in these patients was the use of Ace bandages in the ambulatory patients having ulcers secondary to varicose veins and in the healed ones after their release from the hospital.

Biopsies, cultures, radiography and other laboratory procedures were used in establishing the diagnoses. All of the patients studied in this investigation were charity cases and in none was the diet optimal. On the other hand, demonstrable clinical signs or symptoms of avitaminosis were not

noted in either series. Those in the hospital received a general diet and no extra vitamins were administered orally.

The cod-liver oil was mixed with equal parts of anhydrous lanolin and a generous amount of this mixture was applied to the ulcer. These applications were renewed every second day. Ordinary gauze bandages covered with oil silk were used over the medication. The patient was advised not to use the extremity under treatment any more than was absolutely necessary. Those in the control series were treated in the same manner except that anhydrous lanolin alone was used as a local dressing.

Plain cod-liver oil was employed in several patients suffering from eczema or pyoderma. The results were disappointing in most instances although marked improvement was occasionally obtained in pyogenic infections.

It is unfortunate that no accurate method of comparison has been devised for the study of ulcers of the skin. The prognosis varies greatly with the size, duration and cause of the ulcer so that the length of time necessary to affect a cure is not an accurate measure of the healing power of any remedy. Therefore, it has been found necessary to offer a clinical impression of the results obtained rather than a definite system of grading although the latter would be preferable if practicable.

"Good" results in this study indicates complete healing of the ulcer within a "reasonable length of time," dependent on the factors mentioned which in general was three to six weeks. The fallacy of this method is clearly shown in the two series presented in this report. The results with cod-liver oil were slightly superior to those obtained with the anhydrous lanolin alone

\* From the Department of Dermatology and Syphilology, Los Angeles County Hospital, Los Angeles, Calif.

but the percentage of "good" results obtained in the two series does not demonstrate this difference.

### RESULTS

In reviewing Table 1 which presents a comparison of the two series, one is impressed by the fact that simpler cases were treated with anhydrous lanolin alone rather than with cod-liver oil and anhydrous lanolin together. There were 22 per cent more varicose ulcers in the control series and there were 22 per cent fewer ulcers of more than one year duration. The one ulcer that had persisted for thirty-five years made the average duration greater in the second group.

A fact not recorded in Table 1 is that epithelialization proceeded more rapidly with the high vitamin preparation although healthy granulation tissue was formed equally well with anhydrous lanolin.

The basic problem of correcting the underlying etiological agents was purposely avoided in this study. This was done in order to test the actual healing power of the preparations being studied without introducing other factors. As a result, 6 of the patients treated with cod-liver oil and 2 of the control cases have already suffered recurrences.

The only complication noted during the use of anhydrous lanolin was the appearance of a new lesion in the area being treated in a patient with a trophic ulcer due to a central nervous system lesion. The complications with cod-liver oil included a dermatitis venanata that developed after two weeks of treatment, and recurred with each subsequent application of the oil. This patient also had an associated stasis eczema. An infection with *Bacilli pyocyaneus* occurred in another patient and did not clear with further applications of cod-liver oil.

In studying these cases, it was noted that an ulcer that recurs after being "healed" with either of these preparations, does not respond as well when treated with the same preparation a second time.

### DISCUSSION

Many attempts have been made to demonstrate the mode of action of cod-

TABLE 1  
A COMPARISON BETWEEN THE TWO SERIES

|  | Cod-liver Oil and Anhydrous Lanolin |          | Anhydrous Lanolin |          |
|--|-------------------------------------|----------|-------------------|----------|
|  | No. Cases<br>21                     | Per Cent | No. Cases<br>10   | Per Cent |
| Sex  |                                     |          |                   |          |
| Male.....                                    | 15                                  | 71.4     | 6                 | 60       |
| Female.....                                  | 6                                   | 28.6     | 4                 | 40       |
| Age  |                                     |          |                   |          |
| Youngest.....                                | 20                                  |          | 35                |          |
| Oldest.....                                  | 73                                  |          | 71                |          |
| Average.....                                 | 53                                  |          | 54.8              |          |
| Diagnosis                                    |                                     |          |                   |          |
| Varicose.....                                | 8                                   | 38.1     | 6                 | 60       |
| Microaerophilic hemolytic streptococcus..... | 2                                   | 9.5      | 0                 |          |
| Arteriosclerosis.....                        | 2                                   | 9.5      | 0                 |          |
| Decubitus.....                               | 2                                   | 9.5      | 1                 | 10       |
| Traumatic.....                               | 1                                   | 4.8      | 1                 | 10       |
| Trophic.....                                 | 1                                   | 4.8      | 1                 | 10       |
| Thromboangiitis obliterans.....              | 1                                   | 4.8      | 0                 |          |
| Thrombophlebitis.....                        | 1                                   | 4.8      | 0                 |          |
| Acrodermatitis chronica atrophicans.....     | 1                                   | 4.8      | 0                 |          |
| Scleroderma.....                             | 1                                   | 4.8      | 0                 |          |
| Coccidioides.....                            | 1                                   | 4.8      | 0                 |          |
| Poorly healed fracture.....                  | 0                                   |          | 1                 | 10       |
| Size of ulcer                                |                                     |          |                   |          |
| Largest.....                                 | 190 X 160 mm.                       |          | 150 X 28 mm.      |          |
| Smallest.....                                | 20 X 15 mm.                         |          | 15 X 3 mm.        |          |
| Average.....                                 | 3013 sq. mm.                        |          | 1291.5 sq. mm.    |          |
| Duration                                     |                                     |          |                   |          |
| Longest.....                                 | 1 1/2 years                         |          | 35 years          |          |
| Shortest.....                                | 1 week                              |          | 2 weeks           |          |
| Average.....                                 | 2.9 years                           |          | 6 years           |          |

|   | Cod-liver Oil and Anhydrous Lanolin |          | Anhydrous Lanolin |          |
|---|-------------------------------------|----------|-------------------|----------|
|   | No. Cases<br>21                     | Per Cent | No. Cases<br>10   | Per Cent |
| Duration                                  |                                     |          |                   |          |
| More than 1 year.....                     | 13                                  | 61.9     | 4                 | 40       |
| Results                                   |                                     |          |                   |          |
| Good.....                                 | 14                                  | 66.6     | 7                 | 70       |
| Fair.....                                 | 3                                   | 14.3     | 2                 | 20       |
| Poor.....                                 | 4                                   | 19.1     | 1                 | 10       |
| Ambulatory.....                           | 3                                   | 14.3     | 2                 | 20       |
| Complications                             |                                     |          |                   |          |
| Recurrences.....                          | 6                                   | 28.6     | 2                 | 20       |
| B. pyocyaneus infection ...               | 1                                   | 4.8      | 0                 |          |
| Dermatitis venanata.....                  | 1                                   | 4.8      | 0                 |          |
| New ulcer developing under treatment..... | 0                                   |          | 1                 | 10       |

liver oil in the healing of ulcers. All investigators to date believe the results to be due to the action of the vitamins. Wolbach and Howe<sup>4</sup> pointed out that epithelial repair occurs with recovery from vitamin A deficiencies. Nordman, Bisceglie and Katzenstein (quoted by Loehr<sup>1b</sup>) demonstrated that vitamins stimulated growth in tissue cultures. Dietrich (also quoted by Loehr<sup>1b</sup>) injected vitamin D concentrates into the ears of rabbits and found that this produced epithelial cysts and proliferation.

It has long been held that vitamins are necessary to maintain the integrity and to promote the repair of the epithelial structures of the body. Santi<sup>5</sup> feels that peptic ulcers can be produced in rats by the use of a vitamin A-free diet.

Loehr<sup>1b</sup> has noted that cod-liver oil is sterile and that when streptococci, staphylococci and *Bacilli coli* are introduced into it they are soon destroyed. Cultures taken from ulcers under local vitamin treatment continue to show the presence of these organisms for some time. Loehr, however, postulated that they have lost their toxicity. This is an important concept as ulcers kept at rest and free from infection tend to heal. In this series, microaerophilic hemolytic streptococci were neither destroyed nor rendered non-toxic.

Macintyre<sup>3a</sup> in 1931 reported a cure in a chronic ulcer by the use of "artificial sunlight." Horn and Sandor<sup>11</sup> and Zoltan<sup>12</sup> have reported encouraging results in wounds treated with local applications of vitamin A. Loehr<sup>1a, b</sup> has been using cod-liver oil and vaseline dressings in wounds for more than three and one-half years and is very enthusiastic about the results obtained. Schmier<sup>6</sup> secured good results with metuvit in ulcers of the skin. Metuvit is an ointment consisting of zinc oxide, lithium and certain animal fats subjected to quartz lamp irradiation.

There are certain advantages to be gained by employing cod-liver oil in the treatment of ulcers. Its outstanding characteristic is found in its prompt relief of pain. The wounds are kept free from most

pyogenic organisms. The necrotic tissue rapidly sloughs away from the living tissue leaving a clean granulating surface. Epithelialization proceeds at a fairly rapid rate. In this inadequate series, the ulcers were at least temporarily healed in the majority of instances.

On the other hand, a number of disadvantages are also apparent. The odor is very unpleasant although the patient eventually becomes accustomed to it. The treatment is expensive as large amounts of the mixture are necessary to keep the lesions saturated. It is very difficult to remove the odor from the bed clothes and if washed with other clothes, the odor permeates the latter. Granulation tissue forms more rapidly than the epithelial tissue so that it becomes necessary to cauterize the granulations at intervals. Recurrences are apt to occur if local therapy alone is employed. The oil may increase the toxicity of anaerobic organisms by its effect on the environment and it does not destroy *Bacillus pyocyaneus*. A contact dermatitis may also occur in susceptible patients. It does not cure the surrounding stasis eczema nor does it relieve associated pruritus. Its superiority over anhydrous lanolin is questionable and the disadvantages probably outweigh the advantages.

The main objection is that "good" results were obtained in only two-thirds of the cases in this small series. Fair results or failures occurred in microaerophilic hemolytic streptococcus infections (2 cases), varicose ulcers (2 cases), arteriosclerosis (1 case), coccidioides (1 case) and acrodermatitis chronica atrophicans (1 case). Three of these cases were of less than one and one-quarter years duration. Recurrences have already occurred in nearly 30 per cent of the patients including 5 who were listed as "good" results.

The results obtained with anhydrous lanolin alone were almost equal to those that followed the use of equal parts of cod-liver oil and anhydrous lanolin. In a general way, the advantages and disad-

vantages of the treatment of ulcerations of the skin with cod-liver oil apply to the use of anhydrous lanolin. In this series, cod-liver oil applied locally did not prove itself to be a satisfactory method of treating skin ulcers. However, the prompt relief of pain that usually follows the application of this preparation suggests that it may prove to be a valuable addition to the other means of treating ulcers that are now being employed. It is certain that it should not supplant therapy aimed at correcting basic etiological factors.

## SUMMARY

1. Equal parts of cod-liver oil and anhydrous lanolin applied locally healed ulcerations of the skin in two-thirds of the patients in this series.

2. Anhydrous lanolin alone gave comparable results.

3. It is possible that the vitamin content of the oil enhances its healing powers by stimulating epithelialization.

4. Cod-liver oil alone does not constitute sufficient treatment as it does not offer permanent results in the majority of ulcerations of the skin.

## REFERENCES

- 1a. BUCHNER, O. Cod-liver oil in the treatment of wounds. *Deutsch. med. Wchnschr.*, 61: 2067 (Dec. 20) 1935.
- b. BUCKHEISTER, H. Honey and cod-liver oil in the treatment of wounds. *München. med. Wchnschr.*, 82: 1612 (Oct. 4) 1935.
- c. DRIGALSKI, W. Local action of vitamins in cod-liver oil bandages. *Ztschr. f. Vitaminforsch.*, 3: 260 (Oct.) 1934.
- d. HORN, Z. and SANDOR, I. Local application of vitamin A in therapy of wounds. *Deutsch. med. Wchnschr.*, 60: 1018 (July 6) 1934.
- e. LANG. Cod-liver oil in the treatment of wounds. *Schweiz. med. Wchnschr.*, 65: 1248 (Dec. 28) 1935.
- f. LAUBER, H. J. and ROCHOLL, H. Experimental studies on action of vitamin ointments on healing. *Klin. Wchnschr.*, 14: 1143 (Aug. 10) 1935.
- g. LOEHR, W. Cod-liver oil therapy of extensive burns of first, second and third degrees. *Chirurg.*, 6: 263 (April) 1934; Cod-liver oil and plaster of Paris casts in poorly healing ulcerated stumps with large tissue defects due to charring, freezing or amputation. *Zentralbl. f. Chir.*, 61: 1815 (Aug. 4) 1934.
- h. *Idem*. The treatment of fresh injuries, burns and phlegmonous inflammations with cod-liver oil salve with and without plaster. *Tag. d. deutsch. Ges. f. Chir.*, 58, 1934.
- i. LUCKE, H. Honey and cod-liver oil in the treatment of wounds. *Deutsch. med. Wchnschr.*, 61: 1638 (Oct. 11) 1935.
- j. MEMMESHEIMER, A. M. Effect of massaging skin with ointments containing cholesterol and vitamins. *Deutsch. med. Wchnschr.*, 60: 935 (June 22) 1934.
- k. TUMANSKIY, V. K. and YATSEVICH, I. A. Cod-liver oil in the treatment of infected wounds. *Klin. Med.*, 13: 1528 (Oct.) 1935.
- l. ZOLTAN, L. Vitamins in the treatment of wounds. *Zentralbl. f. Chir.*, 62: 3031 (Dec. 21) 1935.
2. DEJUST, L. H. Local action of vitamins. *Rev. de path. comparee*, 34: 1771 (Dec.) 1934.
- 3a. MACINTYRE, E. J. Long standing ulcer healed by "artificial sunlight," case. *Brit. Jour. Actinotherapy*, 5: 263 (March) 1931.
- b. STEEL, J. P. Cod-liver oil in the treatment of burns. *Lancet*, 2: 290 (Aug. 10) 1935.
4. WOLBACH, S. B. and HOWE, P. R. Epithelial repair in recovery from deficiency in vitamin A. *Jour. Exper. Med.*, 57: 511 (March) 1933.
5. SANTI, M. Experiments on rats indicate that deficiency of vitamin A is cause of peptic ulcer. *Med. ital.*, 12: 155 (March) 1931.
6. SCHMIER, A. A. Treatment of ulcers. *Am. Jour. Surg.*, 23: 198 (Jan.) 1934.





# LYMPHOSARCOMA OF STOMACH: CLINICAL AND ROENTGENOLOGICAL ASPECTS

REVIEW OF RECENT LITERATURE; REPORT OF A CASE\*

S. D. ZAPH, M.D., HARRY A. OLIN, M.D. AND J. D. KIRSHBAUM, M.D.

CHICAGO, ILL.

THE recognition of a malignant gastric lesion as a rule does not present much difficulty in diagnosis. Gastric carcinoma, in the majority of instances, is readily recognized and the roentgen study affords conclusive evidence. However, the foregoing cannot be claimed for gastric sarcoma since this neoplasm may simulate in its earliest manifestations, carcinoma or even a benign lesion. There are no characteristic signs or symptoms for sarcoma, and early diagnosis may offer extreme difficulty for the clinician. At times the pathologist is puzzled, even with his gross tumor and sections to guide him, as some infiltrating cellular carcinoma with anaplastic cells may closely simulate sarcoma and some believe, have been reported as carcinoma. Besides, the secondary tumor nodules of quite typical sarcoma strongly resemble carcinoma and hence may readily lead to error in diagnosis.

That pathological difficulties do arise, is well shown by Freeman who reported a case of gastric sarcoma in which noted pathologists presented a diagnosis of carcinoma, lymphosarcoma, inflammatory tissue and chronic granuloma.<sup>1</sup>

The age as given in the literature varies exceedingly. Finlayson reports a case of a child three and one-half years old, whereas Gosset records a case with the age of eighty-five years. The average age is about forty years, whereas in carcinoma, it is fifty-five years. In the Mayo clinic, the age of the youngest case reported is ten years, the oldest is sixty-seven years and the average is forty-three years. These figures confirm the opinion that one obtains from the literature, that sarcoma occurs earlier

in life than carcinoma and that it is about equal in both sexes. In the Mayo Clinic the ratio is 3 males to 1 female.<sup>2</sup>

## SYMPTOMATOLOGY

This presents a much varied picture as viewed in the literature, particularly in the last few years.

From symptomatology one is unable to differentiate sarcoma from carcinoma of the stomach, as no one symptom or group of symptoms can be considered characteristic; the presenting complaints of dyspepsia, pain, tumor, bleeding, weakness, loss of weight, vomiting and anemia are common to both conditions. In some cases the symptoms of peptic ulcer predominate.<sup>3</sup> According to Cecil,<sup>4</sup> the general health may be better than gastric cancer. Tremendous hemorrhages may occur from which there may be recovery with periods of remission. The case we are about to report, exhibited general good health and the blood picture was normal although the loss of weight was moderate, about twelve to fifteen pounds in six months.

The authors' case, to add to the complexity of diagnosis, presented a four plus spinal Wassermann and had intensive antileptic treatment at intervals covering a period of about twelve years. As syphilitic infiltration may occur in patients presenting an epigastric mass such as our case exhibited, this possibility was borne in mind. In our comments of the reported case more details are offered concerning the diagnosis of gastric syphilis.

Hameed<sup>5</sup> reports a case of gastric lymphosarcoma presenting an intense anemia, optic neuritis and some wasting of the muscles of the extremities. The

\* From Departments of Surgery, Pathology and Roentgenology. Woodlawn Hospital, Chicago.

symptoms did not indicate a new growth and whether the toxic condition accounted for the neuritis or active infiltration of the

tory laparotomy disclosed extensive lymphosarcoma of the cecum with involvement of the glands along the ureter and invaded

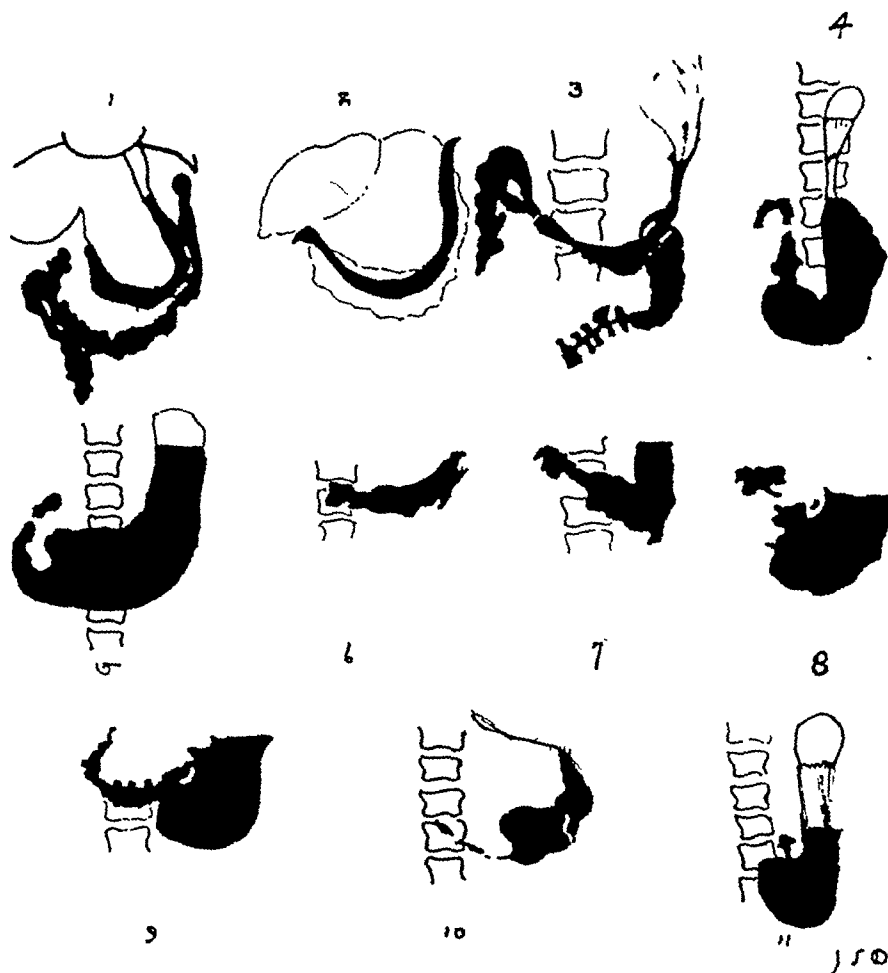


FIG. 1. Various types of sarcoma of stomach, from histologically proved cases: 1, broad based exogastric sarcoma of lesser curvature, myosarcoma (Gosset); 2, exogastric sarcoma of lesser curvature, myxosarcoma (Heller-Konjetzny); 3, broad based exogastric sarcoma of lesser curvature, polymorphocellular sarcoma; 4, broad based exogastric sarcoma of greater curvature, spindle cell sarcoma (Ludin); 5, endogastric sarcoma, spindle cell sarcoma (Geymüller); 6, sarcoma of greater curvature, lymphosarcoma; 7, infiltrating sarcoma of anterior wall, extending from antrum to pylorus, reticulosarcoma (Jaki); 8, sarcoma of lesser curvature, large cell type of round cell sarcoma (Bohmansson); 9, sarcoma of pylorus, round cell sarcoma (Bohmansson); 10, infiltrating tumor of cardia extending to pylorus, lymphosarcoma (Nissen); 11, circular stenosing tumor of pylorus, lymphosarcoma. (The Year Book of Radiology, Chicago, Year Book Publisher, 1935, p. 208.)

spinal cord and its nerves, remained undetermined as permission to remove the spinal cord was withheld. Leucopenia and a relative increase in lymphocytes constituted the main findings in the blood picture.

Harper<sup>6</sup> reports a case of lymphosarcoma of the stomach in a man of sixty years, who thirteen years previously had a cervical node excised, pathologically sarcomatous. Nine years later, an explora-

the peritoneum. No surgery was attempted but the case received intensive irradiation. Five weeks prior to admission, the patient vomited about 50 c.c. of fresh blood. Balfour excised a large tumor of the stomach, for fear of another hemorrhage, and found lymphosarcoma. A jejunostomy was performed for feeding. Microscopical examination of the tumor revealed the same type of tissue as found in the cecum nine years previously.

Husted<sup>7</sup> believes that most cases of gastric sarcoma are discovered at autopsy with a few cases found at operation,



FIG. 2. Lymphosarcoma of stomach. Note marked defect of horizontal portion with canalization of the antrum. Irregularity indistinguishable from carcinoma or syphilis, although indented relief suggests sarcoma.

and are rarely recognized clinically. Melena or occult hemorrhages seem fairly constant. Muscatello<sup>8</sup> reports a case of primary lymphoblastoma of the stomach with metastasis to the ovaries. Cain, Hillemand and Mezard<sup>9</sup> differentiate Hodgkin's disease, generalized lymphosarcoma and local sarcoma of the stomach. They believe there are no outstanding clinical signs or symptoms.

Balfour and McCann<sup>10</sup> reported a series of 54 cases of sarcoma of the stomach which were studied at the Mayo Clinic from January, 1908 to July, 1929, inclusive. Diagnosis was made in all cases as a result of operation except one in which sarcoma was found at necropsy. In 5 cases no tissue was removed at operation and the diagnosis was based upon the gross appearance of the inoperable tumor. To again demonstrate the difficulty of diagnosis, the pathologist reported the possibility of cellular carcinoma in 3 cases and one case involved the stoma of a gastroenterostomy. A total of 4159 cases of gastric malignant lesions were grouped of which 45 were proved gastric sarcoma, and 9 were probable sarcoma. Their figures<sup>10</sup> are tabulated (Table 1).

TABLE 1  
COMPARISON OF FREQUENCY OF SARCOMA AND CARCINOMA\*

| Period    | Sarcoma | Carcinoma | Ratio |
|-----------|---------|-----------|-------|
| 1908-1915 | 5       | 1131      | 1:226 |
| 1916-1920 | 15      | 973       | 1:65  |
| 1921-1925 | 21      | 1185      | 1:56  |
| 1926-1928 | 6       | 823       | 1:137 |

\* Balfour and McCann.

Haggard<sup>11</sup> collected from the literature 244 cases up to 1920 and reported an analysis of 107 operated cases.

#### OBSERVATIONS OF ROENTGENOGRAPHIC DIAGNOSIS OF SARCOMA OF STOMACH

In 4509 malignant tumors of the stomach operated in 7 clinics in various parts of the world, 48 sarcomas were found. If after a roentgen examination, primary sarcoma is considered, the probability in diagnosis is slightly over 1 per cent. Causes are unknown and it is believed that sarcoma does not originate from ulcer although an ulcer history is elicited in some cases.

Localization is said will permit a probable diagnosis. It appears as a single tumor; if multiple, metastases of a primary tumor are probable. In 48 cases from the literature, the site was found in the greater curvature 14 times; in the pylorus 14 times; in the lesser curvature 11 times; the posterior wall 6 times; the anterior wall 8 times. Diffuse infiltration was found 4 times and the cardia was the seat of the tumor in one case. Pyloric stenosis is unusual.

In histologic structure, primary sarcoma of the stomach may be round cell sarcoma, lymphosarcoma, spindle cell sarcoma, fibrosarcoma, myosarcoma and polymorphocellular sarcoma. Other forms are rarer.<sup>12</sup>

In about one-half of the cases Eusterman and Balfour<sup>2</sup> were able to demonstrate a tumor mass, although in their series a few of the cases presented themselves with a mass as a leading symptom. The tumor may be fixed, move with respiration, or

may be only palpable in the standing position. In the few cases where pyloric obstruction exists, gastric peristalsis may be seen

In some cases the mucosa is intact, whereas in others, the defect ranges from perforation of 1 mm. in diameter to exten-



FIG. 3. Gastric lymphosarcoma. Photomicrograph of a section through the stomach. Note the heavy infiltration of the mucosa and the submucosa by tumor cells. ( $\times 65$ .)

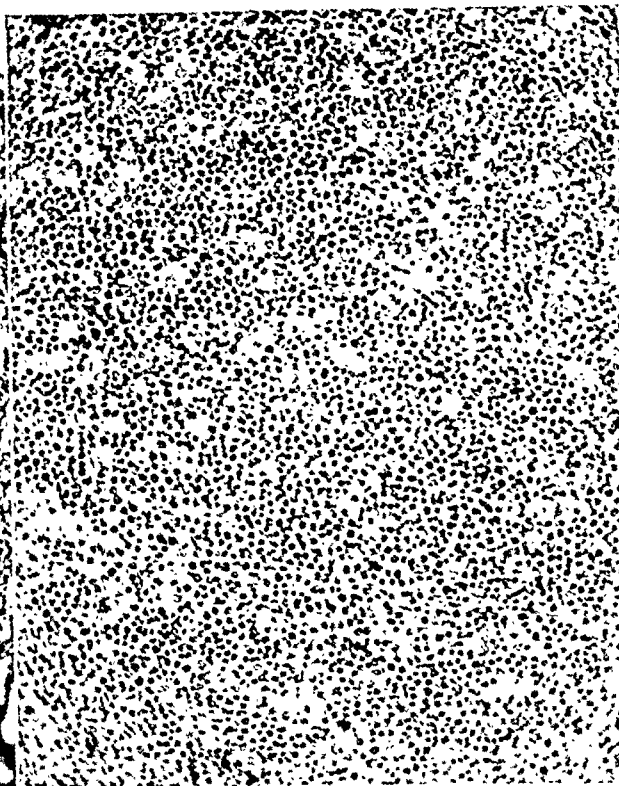


FIG. 4. Lymphosarcoma of lymph node (metastatic). Photomicrograph of a section from the periaortic lymph node. The normal architecture is obscured by the dense infiltration of large lymphocytes and proliferated reticulum cells. ( $\times 135$ .)

occasionally. The size of the tumor may vary from 3 cm. to include almost the entire stomach by massive infiltration.

The same authors report that the location of the tumor is frequently in the antrum but usually far enough from the pylorus as to rarely obstruct it. In one of their cases the lesion caused pyloric obstruction and in another the lesion passed beyond the pylorus into the duodenum. They found that the cardia was never involved. The more common situation was the lesser curvature, but the greater curvature, anterior and posterior walls, were also the sites of origin. In inoperable cases tumors involving the pancreas and extending into the omentum were reported. Occasionally, a secondary mass was found in the pelvis or associated multiple small tumors in the colon.

sive areas of ulceration. Frequently patients who give histories of gastrointestinal hemorrhages had ulceration or perforation.<sup>2</sup>

Rentschler and Travis<sup>13</sup> reported a case of gastric lymphosarcoma and tuberculosis occurring simultaneously in a female, aged sixty-five years, who gave a peptic ulcer history of seventeen years duration. There were no hemorrhages but the patient presented a secondary anemia.

Syphilis of the stomach may greatly resemble lymphosarcoma. The characteristic lesion of syphilis has been described as a flat plaque-like infiltrate which primarily involves the submucosa and its distinctive feature is its soft consistency.<sup>14</sup> This relatively flat tumor combined with its softness may escape detection, two characteristics that an infiltrating sarcoma of the stomach wall may possess, although the

degree of consistency may be more firm in sarcoma.

The following is a comparative group table of the essential clinical factors taken from the Mayo Clinic by Balfour and McCann<sup>10</sup> and from seven clinics in various parts of the world as published in the 1935 Yearbook of Radiology. Mention in the latter is made of Kundrat's symptom, a swelling of the lymph follicles at the base of the tongue, important for differential diagnosis; according to Konjetzny, it favors regional aleucemic lymphomatosis of the stomach in cases that present a palpable tumor.<sup>11</sup>

TABLE II

| Balfour and McCann <sup>10</sup> Mayo Clinic                            | Seven clinics from various parts of world (Group facts and figures 4709 malignant tumors of stomach) |
|---|--|
| 41 (9 malignant gastric tumors; 4 proved sarcoma; 9 probable, total 44) | 48 gastric sarcoma   |

| Age      | No. Cases |   |
|----------|-----------|---|
| Years    |           |   |
| 10 to 20 | 2         | Begins between 20 to 30 years, rises rapidly, falling rapidly, in seventh decade. |
| 20 to 30 | 7         |   |
| 30 to 40 | 7         |   |
| 40 to 50 | 16        |   |
| 50 to 60 | 12        |   |
| 60 to 70 | 10        |   |

## Sex.

31 males, 13 females

No significant difference

## Clinical Features.

Varied from localizable gastric disorder to indefinite general abnormal conditions, not indicating seat of disease.

Course may be symptomless or perforation and hemorrhage with death, vomiting in about one-half reported cases (vomitus seldom coffee ground). Palpable tumor more frequent than carcinoma. Blood in stool and secondary anemia, same frequency as in carcinoma. Acidity often lowered but absence of free HCl is not so common as in carcinoma.

## Chief Complaints.

Cachexia appears relatively late

|   | No. Cases |
|---|-----------|
| Dyspepsia . . . . .   | 21        |
| Epigastric pain . . . . .   | 19        |
| Bleeding . . . . .  | 3         |
| Weakness and loss of weight . . . . .                                 | 1         |
| Vomiting . . . . .  | 2         |
| Demonstrable epigastric tumor . . . . .                               | 26        |
| History of G.I. hemorrhage for period of one to nine months . . . . . | 16        |
| Fatal hemorrhage . . . . .  | 1         |

Hemoglobin varied from 8% to 24 per cent.

Gastric chemistry in 42 cases, free HCl absent in 17.

## Weight Loss.

Ranged from 5 to 70 pounds in period varying from two to several years; average loss 23 pounds in four months. Had no loss of weight up to time of operation, in 11 patients.

Weight curve similar to carcinoma.

## Roentgen Studies.

In 45 cases studied, malignant lesion 35 cases; ulcer 3 cases; extragastric tumor, 2 cases; possible benign tumor, 1 case; negative, 5 cases.

Not given.

Emma Kessler reports 4 cases of gastric sarcoma, 3 primary and one which was metastatic from sarcoma of the tonsil. None of the tumors could be diagnosed clinically but the roentgenographic and clinical findings differed from carcinoma.

CASE I. A man, aged forty-two years, showed a peculiar filling defect on the midportion of the greater curvature with smooth margins, painful on palpation at this site. Lymphosarcoma was found at operation.

CASE II. Male, aged twenty-six years, with pyloric stenosis as his chief symptom. Roentgenographic examination showed a circular tumor at the pylorus, which did not look like carcinoma. A round cell sarcoma, rich in microcytes was found.

CASE III. Male, aged forty-eight years, had a rapidly growing tumor in the upper abdomen without objective symptoms. Roentgenologic examination showed a huge tumor in the epigastrium above the lesser curvature which was not movable on the stomach. A cystic tumor of the pancreas was suggested and was maintained, even after exploratory laparotomy, but autopsy showed polymorphocellular sarcoma arising from the lesser curvature.

CASE IV. This case in a fifty-six year old male, was secondary to a reticulothelial sarcoma of the tonsil which disappeared after fractionated irradiation. Later a nodular filling defect was seen roentgenologically, beginning at the cardia and including the upper third of the lesser curvature. In the fundus, the tumor was recognizable as a soft parts shadow. In the upper third of the greater curvature, a defect the size of a hen's egg was seen. Simple fractionated irradiation, 360 r to each of the two fields, was applied and the gastric picture became normal. A retroperitoneal infiltrate was later demonstrated and successfully irradiated. The patient finally died but no autopsy was done.

Kessler<sup>16</sup> has investigated the relationship between the roentgenologic picture and the histologic type of sarcoma and the following diagram shows the types. (Fig. 1.) Kessler is of the opinion that smoothness of contour should suggest sarcoma but at times sarcoma presents an indented relief. When the tumor alone is found on the greater curvature and lacks the typical

saucer shape of carcinoma at this site, sarcoma is to be strongly considered. This author establishes these criteria, which in

not infiltrate the adjoining walls of the stomach. Mechanical disturbances, hemorrhages, anemia, cachexia, etc., most often

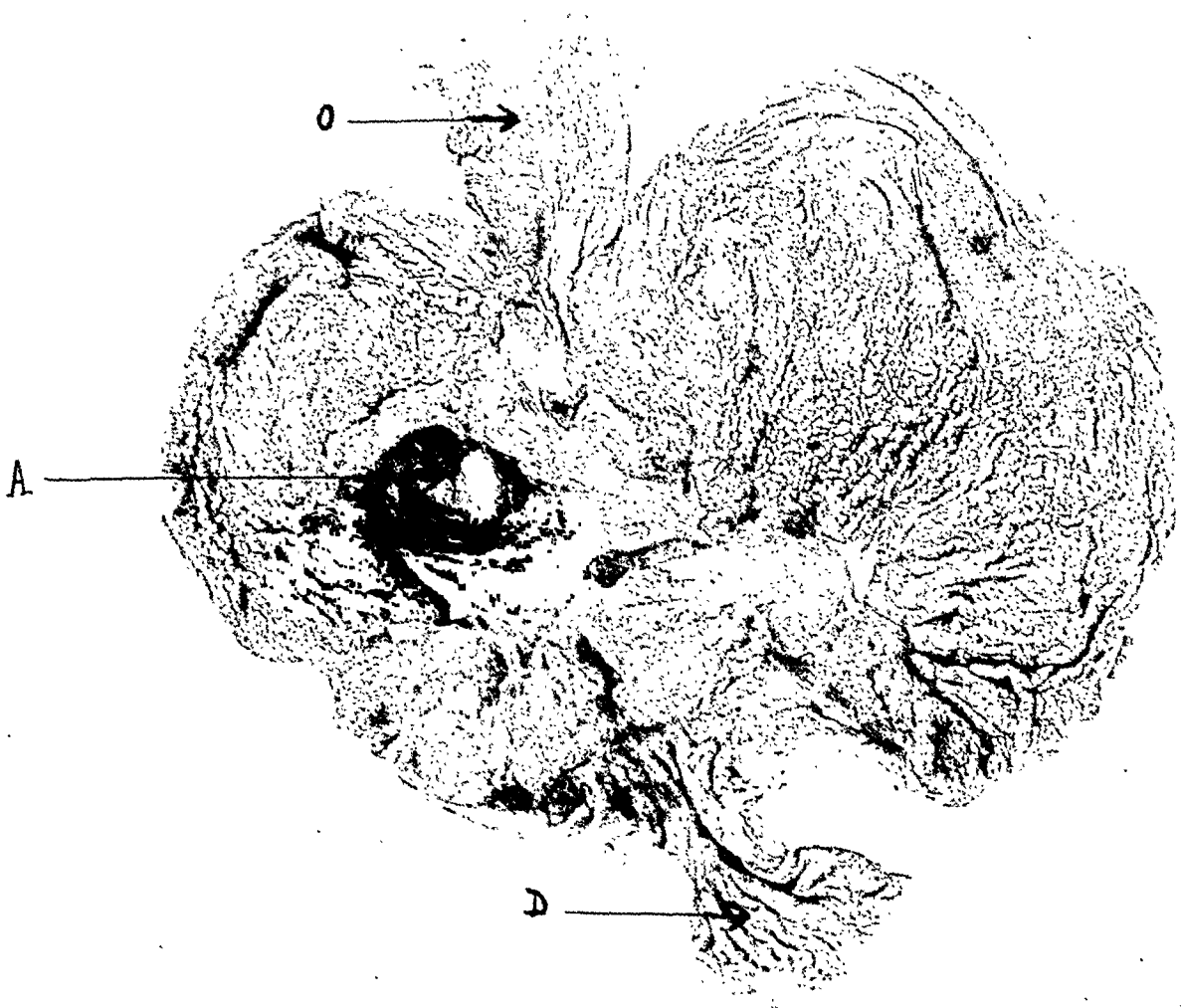


FIG. 5. Photograph of lymphosarcoma of stomach. Arrow A points to perforation in fundus near lesser curvature at site of large defect in mucosa. Note massive invasion of gastric wall with tumor tissue. O, (esophagus,) D; duodenum.

special cases taken together, may make the diagnosis. However to these criteria will be added others as further cases are studied, and detailed observations and roentgenologic studies are made.

Kandrnka and Sierro, of Geneva, are of the opinion that no clinical syndrome is characteristic of all forms of primary gastric sarcoma, however, they believe that in two of the three groups, it is possible, by their anatomic image, to render a diagnosis without histologic examination. These two types are the endo- and exogastric pedunculated tumors.

The endogastric pedunculated tumor has a rounded form with smooth borders and the mucosa ulcerates rapidly; it does

lead to its discovery. The characteristic radiologic signs are a rounded lacuna with distinct borders and relative mobility with regard to its gastric walls. There is a persistent notch in the curvature adjacent to the tumor, corresponding to implantation of the pedicle. The mucosa is supple where peristalsis occurs.

In exogastric pedunculated sarcoma, signs of compression of the neighboring abdominal organs, displacement or dislocation of the stomach must be sought. A cone of attraction at the foot of a narrow pedicle and small irregular contours in the walls of the stomach may be present; mucosal lesions are not usually seen.

They believe that from the anatomico-macroscopic standpoint, the diagnosis of intramural and lymphosarcoma is difficult,

tumor are factors which may suggest sarcoma. To these may be added roentgen ray therapy; if the size of the tumor is

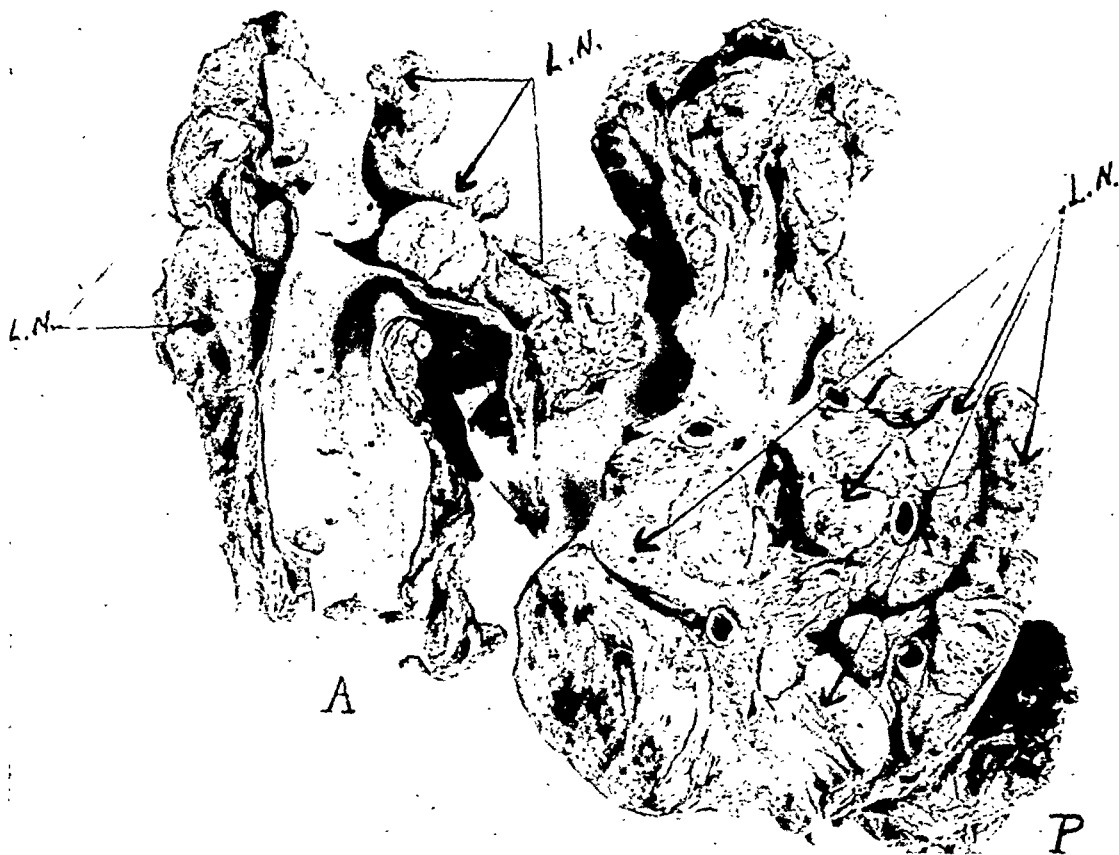


FIG. 6. Photograph of A, aorta; P, pancreas. Note marked enlargement of nodes about aorta and pancreas. L.N., enlarged masses of lymph nodes (metastatic from gastric lymphosarcoma).

if not impossible. This type of tumor infiltrates the gastric wall, spreads by nodular dissemination which becomes confluent rendering a homogeneous appearance to the mass and greatly simulates the appearance of a carcinoma. The radiologic signs of rigidity of the gastric wall, stenosis with canalization, stricture and even stenosis go hand in hand with carcinoma and it is impossible to differentiate. Biopsy through exploratory laparotomy or preferably an external node, as the supraclavicular node, if found, offers the safest means for certain diagnosis. The authors' case presented similar roentgenographic manifestations. Kundrat's sign, splenomegaly, continuous fever and persistent peristalsis at the level of the

diminished, the clinical diagnosis of sarcoma may be entertained.<sup>17</sup>

Spitzenberger,<sup>18</sup> of Vienna, is of the opinion that when the tumor mass proliferates through the diaphragm embarrassing the heart, that it is more likely to be sarcoma than carcinoma. The greater curvature of the fundus, he believes is the predilected site for sarcoma, whereas in carcinoma the cardia is more frequently attacked. He reports a case of a large tumor of the fundus which proliferated through the diaphragm and which histologically proved to be lymphosarcoma. This tumor infiltrated the spleen causing marked enlargement of the organ and produced a large shadow defect in the fundus involving the greater curvature.

### \* PATHOLOGY

Voeckler<sup>19</sup> reports a series of 130 cases operated for malignancy of the stomach in which were 4 cases of sarcoma, an incidence of 3 per cent. In a small series this percentage may occur as much larger series reveal an incidence slightly over one per cent. He mentions the exogastric, endogastric, and intramural types and histologically, (1) a. round cell; b. spindle cell; (2) lymphoid; (3) fibro- or myosarcoma; (4) polymorphocellular; (5) mixed cell (lymphocytic and reticulum), (6) angio- or lymphangiosarcoma.

The exogastric type predominates. To this group may be included the reticulo-thelial sarcoma. (Refer to Case iv in Kessler's group of a metastatic gastric sarcoma following a primary sarcoma of the tonsil.)

In a pathologic study of 40 operated cases at the Mayo Clinic<sup>2</sup> the following histologic types were found: lymphosarcoma 32; fibrosarcoma 5; myosarcoma 3.

As lymphosarcoma is the most susceptible to irradiation, this type offers the most in roentgen therapy.

### ROENTGEN SIGNS

There are no roentgenographic signs, as has been stated, which can be considered pathognomonic of sarcoma. In fact, irregular shadows cast by malignant tumors as a whole remain undifferentiated. From the literature one may entertain a consideration of sarcoma if the tumor is flat and possesses smoothness of contour. An indented relief of outline also strongly suggests sarcoma. Suspicion should be strongly aroused if the tumor alone is located on the greater curvature and looks the typical saucer shape of carcinoma. If extensive infiltration of the wall has occurred, the pars media is replaced by a narrow channel which presents an indented relief much smoother in outline than the gross irregularities exhibited in carcinoma (authors' case).

Peristaltic waves are dependent upon the amount of infiltration of the gastric wall; if infiltration is small, little or no variation will be met in the gastric outline. However, if the intramural infiltration is extensive, peristalsis will be notably absent. These are the roentgenographic signs for the intramural type of sarcoma.

Already reference has been made in the paragraphs on pedunculated tumors, the endo- and exogastric forms of their radiologic signs.

### DIAGNOSIS

Rarely is a diagnosis made before operation as signs and symptoms of any malignancy closely resemble each other. Roentgenologic examination is of the utmost value particularly to estimate the operability of the lesion. But the court of the last resort should be placed in the hands of the surgeon, to explore the lesion, as the surgeon may encounter a large mass sometimes possible of removal even though the roentgen ray reveals extensive involvement of the tumor as an inoperable growth.

Balfour reasons that certain sarcomata are not of the infiltrating type and the line of demarcation is definite. They may even appear to extend into neighboring organs and their origin may be determined by fluoroscopic examination. He found that some tumors perforated and had become fixed to adjacent organs so that at first glance, when the abdomen was opened, they appear impossible to remove. After carefully separating the organs the tumor was found confined to the stomach wall and had not extended beyond it, thus justifying the attempt of removal. If the tumor is in a young child, or in the second or third decade of life, suspect sarcoma. The same author emphasizes exploration of any gastric tumor or lesion unless it is perfectly obvious that the growth is inoperable. Until the diagnosis is proved by pathologic study, the problem is always a question and the



patient should be given the benefit of the doubt whenever possible.<sup>2</sup>

#### SUMMARY

The difficulties of recognizing sarcoma of the stomach are enumerated as the clinical signs closely resemble carcinoma. Local involvement of the stomach associated with an almost normal blood picture in which hemorrhage with recovery has occurred should lead to a probable diagnosis of sarcoma. If in addition, the roentgenographic findings demonstrate a smooth flat tumor or one with a deeply indented relief, sarcoma is a very likely diagnosis to be entertained. The possibility of rendering roentgen ray therapy once a diagnosis is established, may lead to complete regression of the tumor and may offer the most to the patient. It is needless to add that surgical exploration and biopsy are advised, as much can be gained from the information obtained as to the extent and nature of the tumor, and type of therapy to be advised. Cases from the recent literature are briefly reviewed notably those from the 1935 Year Book of Radiology. The authors' case is reported with all the data included.

#### HISTORY

N. D., male, aged fifty years, was admitted to Woodlawn Hospital August 26, 1935, with a tentative diagnosis of gastric lues or carcinoma. He complained of epigastric distress, of three years duration.

*Onset and Course.* Three years ago, the patient began to notice a periodic sensation of burning and fullness in the epigastrium occurring about three hours after meals; the time was regular. He was often awakened at night by the same distress which was at once relieved by taking soda. There were frequent remissions, some lasting several weeks. He soon discovered that bland foods agreed, whereas, meat, vegetables, etc., brought on an attack. He had no nausea or vomiting, no hematemesis. At onset he was worried by business difficulties. No abdominal pain. Occasionally he suffered from facial neuralgic pains and diplopia.

*Sexual History.* He had a positive spinal Wassermann in 1921, but denies chancre; although he had diplopia and facial pain, he never had a rash. He had yearly courses of mercurials, bismuth and arsenicals since. Married since 1928; no children; wife had no miscarriages.

*Physical Examination.* A well developed and nourished male lying quietly in bed, not acutely ill; his weight was about 175 pounds showing a loss of about twelve pounds in six months. The head was negative. The pupils reacted to light and accommodation. The ears and nose were negative. Except for poor teeth, the mouth was negative. His neck showed slight adenopathy, and a palpable, but not enlarged thyroid. Other than few crackling rales over both lung fields, nothing remarkable was found. The heart was negative. The abdomen presented no masses or tenderness; liver border smooth, palpable, and slightly enlarged. A slight hydrocele was noted. Skin showed papules on the back. Bones and joints: no tenderness or deformities. Reflexes: knee jerks active, bilateral; abdominals not elicited; Babinski, negative. Temperature 98; pulse rate 94; respiration 12.

#### ROENTGENOLOGIC STUDY OF GASTROINTESTINAL TRACT

In the G.I. tract the esophagus is normal. The stomach is steerhorn in type, moderately large at the cardiac end which is somewhat dilated with a large defect in the pars media and with canalization consisting of a narrow thin irregular stream as far as the pylorus. On the lesser curvature the irregularity extends to within 5 cm. of the cardiac end. Periodically there is at times a continuous stream of barium passing through the pylorus and outlining the entire duodenum. Peristalsis is definitely diminished and is absent in the involved area. Nothing of note was seen in the five and twenty-four hour observations (Fig. 2).

The urine was negative.

The blood findings showed white blood corpuscles 9600, red blood corpuscles 4,470,000, and hemoglobin 80 per cent. The differential count revealed polymorphonuclear neutrophils 79 per cent, polynuclear eosinophile 1 per cent, small lymphocytes 18 per cent and large mononuclear 2 per cent.

Gastric analysis after introduction of 100 c.c. 7 per cent alcohol gave the following results:

| Time,<br>Minutes | HCl  | Total<br>Acid | Blood             |
|------------------|------|---------------|-------------------|
| 20               | None | 5             | negative negative |
| 40               | None | 4             | negative negative |
| 60               | None |               |                   |

Benzidine blood was negative.

The patient was discharged August 28, 1935, condition unchanged.

In view of the fact that we were definitely dealing with a malignancy of the stomach, grossly inoperable, and with a syphilitic history, antiluetic therapy was the first treatment of choice.

The patient was readmitted September 6, 1935 with recurrence of symptoms. On the day of readmission, he vomited a large amount of blood. He had several attacks of repeated vomiting, much less severe and observed small quantities of blood in the vomitus. This has been the first instance of a hematemesis. He had had no tarry stools. Blood count revealed 21,400 leucocytes with polymorphonuclears 89 per cent and small lymphocytes 4 per cent.

Nodes were now palpable in the left supraclavicular fossa, a very tender group in the left submaxillary region, a node felt in the left epitrochlear and inguinal regions and flat circular mass was felt in the left epigastrium extending under the costal border. He was treated with neoarsphenamine as the history and findings favored gastric lues. The nodes in the left supraclavicular region become more numerous. The patient developed more hemorrhages and on October 4 sustained a perforation, expiring October 5, 1935.

*Essential Pathological Postmortem Findings.*  
*Abdominal Cavity.* The liver extends 6 cm. and 3 cm. below the xiphoid process and the right costal margin. The intestines are distended and matted together by loose fibrinous adhesions. The serosa of the bowel is discolored a purple-gray and cloudy. There are about 500 c.c. of a blood-tinged purulent fluid present. The transverse colon near the hepatic flexure is adherent to the gall bladder.

*Gall Bladder.* The wall is thickened and the mucosa is a light yellowish-tan. In the serosa there are several pinhead sized firm gray nodules.

*Stomach.* Contains about 1500 c.c. of uncoagulated blood. The mucosa is deeply

injected, purple-red and presents many shallow defects. Up to 15 mm. in diameter, beginning 35 mm. above the pylorus in the region of the lesser curvature, there is a huge defect extending up to the cardiac orifice and measuring 105 by 135 mm. The edges of this defect are firm, elevated and ragged. The floor of the ulcer is discolored a dirty purplish-green. In the upper portion of the defect there is a perforation 20 mm. in diameter, communicating with the peritoneal cavity, and is loosely sealed by the inferior surface of the left lobe of the liver. The perigastric lymph nodes are matted together forming a plate 14 by 6 by 2 cm. The inguinal lymph nodes are up to 20 mm. in diameter. The peripancreatic lymph nodes are enlarged up to 30 mm. in diameter, soft, purple-gray and medullary (Figs. 5 and 6).

*Microscopic Examination.* *Stomach.* Throughout the mucosa there are accumulations of large lymphocytes. The cells infiltrate the submucosa forming masses and then are seen extending into the muscularis propria. In the region of the ulceration, the mucosa is completely replaced by dense masses of tumor cells, resembling large lymphocytes (Fig. 3).

Studies of the various lymph nodes reveal a uniform picture in all. The normal architecture is completely obliterated by the dense proliferation of small round cells, resembling lymphocytes. Only strands of trabecula are seen and they are invaded by lymphocytes. The cells contain an oval to round nucleus. The nuclei are composed of a coarse, dense, granular chromatin material. Mitotic figures are numerous. The sinuses are infrequently lined by large, swollen and vacuolated reticular cells. The histological studies reveal a lymphosarcoma of the stomach with extensive metastases to the lymph nodes (Fig. 4).

*Anatomical Diagnosis.* 1. Lymphosarcoma of the stomach with ulceration and perforation into the abdominal cavity.

2. Metastases to the perigastric, peripancreatic, periaortic, inguinal and supraclavicular lymph nodes.

3. Diffuse fibrinopurulent peritonitis.

#### COMMENT OF CASE

A review of the symptomatology and laboratory data of this patient, especially the roentgenographic findings, indicated an advanced neoplastic lesion, infiltrating

in type, involving the antrum and the greater part of the corpus of the stomach. The blood picture at the time of the first admission was essentially normal and with a luetic history suggested the possibility of gastric lues. Gastric carcinoma was the first diagnosis of choice from the roentgenological findings but the normal blood picture spoke against cancer as marked secondary anemia usually accompanies advanced gastric carcinoma. The absence of cachexia in such an extensive lesion combined with a normal blood picture and relatively slight loss in weight, drew the inference that we were dealing with pathology other than carcinoma. The history leaned more toward gastric lues. Lymphosarcoma was not considered although malignancy was borne in mind.

The autopsy findings of a smooth massive gastric infiltration extending into the left lobe of the liver at which point the gastric wall was perforated and the extensive metastases to the surrounding nodes of the pancreas, stomach and aorta indicated sarcoma, which microscopical study confirmed.

#### SUMMARY

While gastric malignancies offer no great diagnostic difficulties, the pathological and clinical differentiation between gastric carcinoma and sarcoma is difficult. A review of the literature indicates that the diagnosis of gastric sarcoma is rarely made preoperatively. However, local involvement of the stomach, associated with an almost normal blood picture in a patient with a history of hemorrhage and recovery, as well as roentgenographic findings of a smooth, flat tumor or one with a deeply indented relief suggests the possibility of sarcoma. The x-ray picture is of particular value in estimating the operability of the lesion and may be of therapeutic value.

A case is reported of a male, fifty years of age, in whom a clinical diagnosis of either gastric malignancy or gastric lues was entertained, but autopsy studies revealed the mass to be a lymphosarcoma with ulceration and perforation into the abdominal cavity and with metastases to the perigastric, peripancreatic, periaortic, inguinal and supraclavicular lymph nodes.

#### REFERENCES

1. FREEMAN, LEONARD. Partial gastrectomy for peptic ulcers coincident with lymphosarcoma of the stomach, recovery. *Colorado Med. Jour.*, 25: 362-367 (Nov.) 1928.
2. EUSTERMAN, GEO. B. and BALFOUR, DONALD C. The Stomach and Duodenum, Phila., W. B. Saunders Co., 1935, pp. 636.
3. Case Reports, Mass. General Hospital. *New England Jour. Med.*, 208: 1167 (June 1) 1933.
4. CECIL, RUSSELL, L. Text Book of Medicine, Phila., W. B. Saunders Co., 1934, pp. 733.
5. HAMEED, M. A. *Brit. Med. Jour.*, 2: 565-608 (Sept. 28) 1935.
6. HARPER, F. R. *Proc. Staff Mayo Clinic*, 7: 515 (Sept.) 1932.
7. HUSTED, E. Case of primary sarcoma of the stomach. *Hospitalstid*, 75: 1005-1010, 1932.
8. MUSCATELLO, F. Case of primary lymphoblastoma of the stomach with metastasis to the ovaries. *Tumori*, 7: 175-188, 1933.
9. CAIN, A., HILLEMANN, P. and MÉZARD, J. Lymphangitis lymphosarcoma of the stomach. *Arch. d. mal. de l'App. Digestif*, 24: 337-353, 1934.
10. BALFOUR, D. C. and McCANN, J. C. Sarcoma of the stomach. *Surg. Gynec. and Obst.*, 50: 948 (June) 1930.
11. HAGGARD, W. D. Sarcoma of the stomach with report of case and an analysis of 107 cases operated on. *Surg. Gynec. and Obst.*, 31: 505 (Nov.) 1920.
12. Year Book of Radiology. Chicago, Year Book Publishers Inc., 1935, pp. 208-210.
13. RENTSCHLER, C. B. and TRAVIS, R. C. *J. A. M. A.*, 102: 686 (Mar. 13) 1934.
14. MEYER, KARL A. and SINGER, HARRY A. Syphilis of the stomach with special reference to its recognition at operation. *Arch. Surg.*, 26: 443-464 (March) 1933.
15. Year Book of Radiology. Chicago, Year Book Publishers, pp. 206, 207, 1935.
16. *Op. cit.*, pp. 208-210.
17. *Op. cit.*, pp. 205.
18. *Op. cit.*, pp. 199.
19. VOECKLER, T. Gastric Sarcoma. *München. med. Wchnschr.*, 82: 667-669, 1935.



# TREATMENT OF ABORTION\*

MORRIS GLASS, M.D., F.A.C.S.

Attending Obstetrician and Gynecologist, Kings County Hospital

BROOKLYN, N. Y.

THE term abortion is applied to all cases of pregnancy terminating before viability of the fetus, i.e., up to the twenty-eighth week. They are classified as threatened, inevitable, incomplete, septic, complete, or missed abortion. We will consider the history, the findings, and the treatment of each type separately.

## THREATENED ABORTION

*History.* One can usually elicit a history of amenorrhea with the associated symptoms of pregnancy referable to that period; such as nausea, vomiting, fullness and tenderness of the breasts, and frequency of urination. Bleeding is slight and often mixed with mucus. Pain is usually absent or the patient may complain of vague intermittent backache.

*Findings.* Vaginal examination should be limited to those cases in which the presence of an intrauterine pregnancy is doubtful. This should be performed with gentleness and under rigid asepsis. The findings are slight vaginal bleeding, the cervix is soft, and the external os is closed. The uterocervical angle is present. The size of the uterus corresponds with the period of amenorrhea, and is soft in consistency.

*Treatment.* Treatment is aimed at eliminating or preventing uterine contractions and controlling the bleeding. This is done by putting the patient to bed, eliminating enemas and cathartics, and administering intramuscularly morphine sulphate grain  $\frac{1}{4}$  every six hours, and one rabbit unit of progestin daily until the bleeding and pain have ceased. Following this, the patient is kept in bed for seventy-two hours and on discharge is cautioned against vigorous activities. If the uterus was found retroverted, the patient is advised to assume

the knee-chest position for ten minutes three times a day.

## INEVITABLE ABORTION

*History.* The initial symptom may be premature rupture of the membranes with the escape of amniotic fluid. In other cases the onset is similar to threatened abortion, but with time, bleeding becomes more profuse and mixed with clots. Pain is a constant symptom and is described by the patient as being intermittent, cramp-like, and localized to the lower part of the back and abdomen.

*Findings.* The vagina is filled with blood. The cervix is soft, and the external os is patulous. Through the dilated cervix part of the ovum frequently protrudes. The uterocervical angle is absent. The uterus is soft and enlarged to correspond with the period of amenorrhea.

*Treatment.* Since the pregnancy can no longer continue our aim is to hasten its termination. Where bleeding is slight, expulsion of the products of conception can be quickened by stimulating uterine contraction. To do this a warm enema, a hypodermic injection of an ampule of obstetrical pituitrin, plus the oral administration of quinine grains 5, at two hour intervals are given for two doses.

Interference becomes imperative if the patient is hemorrhaging. Careful aseptic technique must be followed with every surgical procedure. In the afebrile case, the method of choice depends upon two factors: i.e., the dilatation of the cervix, and the duration of the pregnancy.

Up to the third month, if dilatation is not adequate, graduated Hegar dilators are used to open the cervix. Up to the eighth week the ovum is removed with a dull

\* From the Department of Obstetrics and Gynecology, Long Island College of Medicine.

curette or a small ovum forceps. After this period, one finger in the uterus, alone, or in combination with an ovum forceps, is employed to remove the retained products.

Following the third month, cervical dilatation is facilitated by the use of a tight vaginal pack soaked in 4 per cent mercurochrome. This is removed at the end of twenty-four hours. Then one of two things will usually be noted; either the uterus will have completely emptied itself, or the cervix will be found sufficiently dilated to permit the insertion of one finger into the uterine cavity with which the placenta can be separated off the uterus and then easily removed with a placental forceps.

#### INCOMPLETE ABORTION

*History.* If part of the ovum is left behind, bleeding occurs in varying amounts. This type of abortion is most apt to take place before the ovum becomes firmly attached to the uterus, i.e., after the eighth week. The fetus is usually expelled, and part or the whole of the placenta remains behind in the uterus.

*Findings.* On vaginal examination slight or profuse bleeding is noted. The cervix is soft in consistency and the external os is patulous. The uterus is enlarged. Its size depends partially on the duration of the pregnancy, but mainly on the amount of tissue left in the uterus.

*Treatment.* In the aseptic case, prompt evacuation of these products is advocated to minimize the blood loss and the possibility of infection. The methods employed are similar to those described under the treatment of inevitable abortion.

#### SEPTIC ABORTION

*History.* All criminally induced abortions are potentially septic. A history of chills and fever points to infection. Sepsis is substantiated by temperature elevation, high leucocyte count, and low sedimentation time. Uterine cultures afford some aid in determining the virulence of the infecting agent. A gentle bimanual examination will inform the physician whether the infec-

tion has extended beyond the uterus. The presence of pelvic tenderness, induration, or a mass in either or both fornices are evidences of such extension.

*Treatment.* In the presence of infection, active treatment is limited to those cases which are bleeding profusely. If the cervix is sufficiently dilated, the retained products are gently removed with an ovum forceps. This procedure usually controls the bleeding and institutes adequate drainage. On the other hand if the cervix is closed, bleeding can be controlled and cervical dilatation obtained by packing the vagina tightly with a mercurochrome soaked pack. The pack is removed at the end of twenty-four hours when sufficient cervical dilatation will be present to permit the removal of the retained products with an ovum forceps, or occasionally the products will have been spontaneously discharged from the uterus. Curettage is contraindicated in septic abortion because such manipulation tends to spread the infection beyond the uterus.

Where bleeding is negligible conservative treatment is advocated. This consists in placing the patient's bed in high Fowler's position, and stimulating uterine contractions by placing an ice bag to the lower abdomen, and administering ergotrate, pituitrin, and quinine. Fresh air, sunshine, highly nutritious foods, and frequent small blood transfusions of 300 c.c. every four days are important aids in building up the patient's resistance against the infection. This expectant treatment is followed until the temperature falls to normal and remains so for five days. If at that time, secundines still remain in the uterus they should be gently removed to hasten the patient's convalescence. In most instances the cervix will be adequately dilated to permit the removal of these fragments with a large dull curette or an ovum forceps.

#### COMPLETE ABORTION

*History.* This term is restricted to those cases in which all of the products of conception are expelled. It is most apt to occur before the placenta has become fully de-

veloped; i.e., before the twelfth week. A history of vaginal bleeding and intermittent lower abdominal pains preceding the abortion is usually obtained. After the expulsion of the ovum, pain ceases and is followed by a slight bloody vaginal discharge which persists for a few days.

*Findings.* The cervix is closed and a slight amount of blood issues from it. The uterus is moderately soft in consistency, and smaller than expected for the period of amenorrhea which preceded the abortion.

*Treatment.* The after care of all completed abortions is most important. The patient should be kept in bed until the dangers from complications have subsided and the bleeding has ceased for a week. During this period, uterine involution should be aided by the judicious use of oxytocics, and having the patient assume the knee-chest position. Mammary engorgement, appearing on the third or fourth day, is relieved by a tight breast binder and ice bags.

#### MISSED ABORTION

The term is applied to a pregnancy in which the fetus dies and is retained in the uterus for some time. Litzenberg places an arbitrary limit of two months after fetal death between abortion and missed abortion.

*History.* At the time of fetal death, the patient experiences slight vaginal bleeding in conjunction with vague intermittent uterine contractions. A diagnosis of threatened abortion is made and the patient apparently responds to treatment. As the weeks go by the patient senses that something is wrong. The symptoms of pregnancy cease. The breasts become smaller, the abdomen fails to enlarge, and fetal movements fail to appear. If death of the fetus occurs after the fourth month of pregnancy the patient notes a cessation of fetal activity.

*Findings.* The expected signs of pregnancy for the period of amenorrhea are lacking. Thus there is an absence of fetal life, and the breasts are smaller. Vaginal

examination, in some cases, reveals a slight brownish discharge. The cervix is soft and the uterus is not as large as it should be. The Friedman test often becomes negative and is of inestimable value in those cases which previously yielded a positive result. After the fourth month, roentgenogram will show overlapping of the flat bones of the skull, a positive finding of fetal death. If the diagnosis is still doubtful, re-examinations will demonstrate a failure of the uterus to enlarge, and with time a diminution in its size is demonstrable by actual measurement.

*Treatment.* Spontaneous expulsion of the ovum takes place in the majority of cases with no untoward effects. Occasionally active treatment is necessary. In the early months of pregnancy the cervix should be dilated with graduated Hegar dilators and the ovum removed with a large dull curette or an ovum forceps. In the later months, anterior vaginal hysterotomy may be necessary before the products of conception can be removed.

#### PROPHYLAXIS OF ABORTION

The treatment of a spontaneous abortion is never completed until all possible factors which led to it are ascertained and appropriate methods employed to prevent its recurrence with subsequent pregnancies. With this thought in mind, the fetus and placenta should be carefully examined macroscopically and microscopically for a possible cause. Constitutional disturbances as anemia, syphilis, hypothyroidism, the presence of foci of infection, and nephritis should be ruled out and corrected by a thorough physical examination and a complete laboratory work up. If an altered carbohydrate metabolism or a diet deficient in calcium, or vitamins such as B and E, is the cause for the abortion, the proper steps must be taken to rectify such defects. The knee-chest position and the pessary should be employed to correct a retroverted uterus before and during subsequent pregnancies. A deeply lacerated cervix, or a uterine prolapse may occasionally demand

operative correction before allowing another pregnancy to occur. If the determined cause for frequent abortions lies in an adherent retroverted uterus, operative interference may be necessary to free the uterus and correct the displacement.

The husband must also be thoroughly examined, bearing in mind that many abortions are due to a defective germ plasm. Local evidences of infection, endocrine disturbances, or dietary deficiencies should be corrected. Antuitrin S, and theelin has produced favorable results in increasing the virility of the spermatozoa where a diminished activity existed.

When pregnancy occurs in a patient who habitually aborts, she should avoid strenuous exercises as dancing, swimming, horseback riding, automobiling, etc. Coitus should be eliminated especially during the first trimester of pregnancy. It is advisable to keep her in bed during those periods which would correspond to her menstrual flow had she not been pregnant, since it is found that abortion is more likely to occur at these times than at others. Progestin in one-half rabbit unit doses twice a week in the first trimester of the pregnancy is advocated, especially in those cases where

the cause for the abortion points to an "irritable uterus."

#### SUMMARY

1. The history, the findings and the treatment of the various types of abortion are reviewed.

2. In the diagnosis and the treatment of abortions, all vaginal manipulations must be performed gently and aseptically.

3. In septic abortion, curettage is contraindicated.

4. The treatment of a spontaneous abortion includes a careful search for the factors responsible for this complication. If found they should be corrected or removed, if possible, so that subsequent pregnancies will go to term.

#### REFERENCES

- BECK, A. C. *Obstetrical Practice*. Baltimore, Wilkins and Williams, 1935.  
GORDON, O. A., JR. *Management of Abortion*. *J. A. M. A.*, 82: 1021, 1924.  
LITZENBERG, J. L. Curtis, *Gynecology and Obstetrics*. Vol. 1, Philadelphia, Saunders, 1933.  
MACOMBER, DONALD. *Etiology of Abortion*. *Boston Med. and Surg. Jour.*, 193: 116, 1925.  
TOUSSIG, F. J. *Abortion, Spontaneous and Induced*. St. Louis, Mosby, 1936.



# HYPEREMESIS GRAVIDARUM\*

## ANALYSIS OF 50 CASES

FRED. A. KASSEBOHM, M.D.

AND

MILTON J. SCHREIBER, M.D.

Director of Obstetrics

Assistant Visiting Obstetrician

The Harlem Hospital and The Lutheran Hospital of Manhattan

NEW YORK

**H**OSPITALIZATION in hyperemesis gravidarum patently implies intractability with ultimate interruption of pregnancy versus conservative management and the proper timing of interference with the gestation being the paramount issue. An undivided responsibility for decision, and action thereupon, rests upon the consulting obstetrician. Sequels of observation, judgment and action are often distasteful, occasionally tragic. The consultant is forced into a paradoxical situation by a play of factors contributing to the production of as grave an obstetric situation as commonly obtains in practice. Chief of these are, on one hand, the fallacious, traditional expectation of "morning sickness" by the patient, and on the other, the optimistic outlook of the practitioner who anticipates cessation of nausea and emesis as a corollary of passing time. There is ample statistical justification for both these attitudes, yet, from the early disregard for what is considered a physiologic accompaniment of the first months of gestation, "morning sickness" insidiously progresses into the more vicious state termed pernicious vomiting. When emesis attains that point at which nothing taken by mouth is retained, when even the mention of food or drink actuates violent retching, with the pulse rate climbing, the blood pressure falling, the breath bearing a fruity odor and emaciation evident and advancing, long delayed therapy is sought and hospitalization generally insisted upon. Fifty-one such cases have appeared on our services in the ten years beginning January 1, 1926.

The analysis of this group of cases was undertaken with a fixed purpose as its

goal, primarily to arrive at a better understanding of the agents influencing the progress of "morning sickness." Further, we have sought in the stories of these patients an absolute clinical indication or indications for the proper management of the disease. These findings are presented with sundry observations which may serve in the consideration and treatment of the patient with pernicious vomiting (chart 1).

### INCIDENCE

"Morning sickness" occurs in at least 50 per cent of normal pregnancies, appearing usually between the sixth and eighth week of gestation and persists until the twelfth or fourteenth week and then disappears. In its period of persistence it consists only of nausea and vomiting in the morning on awakening. Rarely it may occur later in the day. Progressing into pernicious vomiting, there occurs gradual accentuation of symptomatology, vomiting occurring at all times independent of stomach content or feeding hours and is apparently uncontrollable.

Hyperemesis is a rare disease. Vomiting for which the patient seeks relief will occur once in 150 cases in private practice. In clinic practice it is seen once in 800 cases. Every case of pernicious vomiting has its roots in the innocuous "morning sickness."

### ETIOLOGY

We have long ceased considering "morning sickness" and hyperemesis as manifestations of "toxemia." Whereas there exists but an hypothetical concept of the disease as of toxic origin, there is extant a mass of clinical and laboratory evidence demonstrating the metabolic dysfunction

\* From the Obstetrical Services of The Harlem Hospital and The Lutheran Hospital of Manhattan, New York.



which underlies the syndrome. To properly present the evidence pointing to defective carbohydrate metabolism as the starting

deprivation. The average normal diet of the woman before pregnancy cannot supply the carbohydrate requirements of the

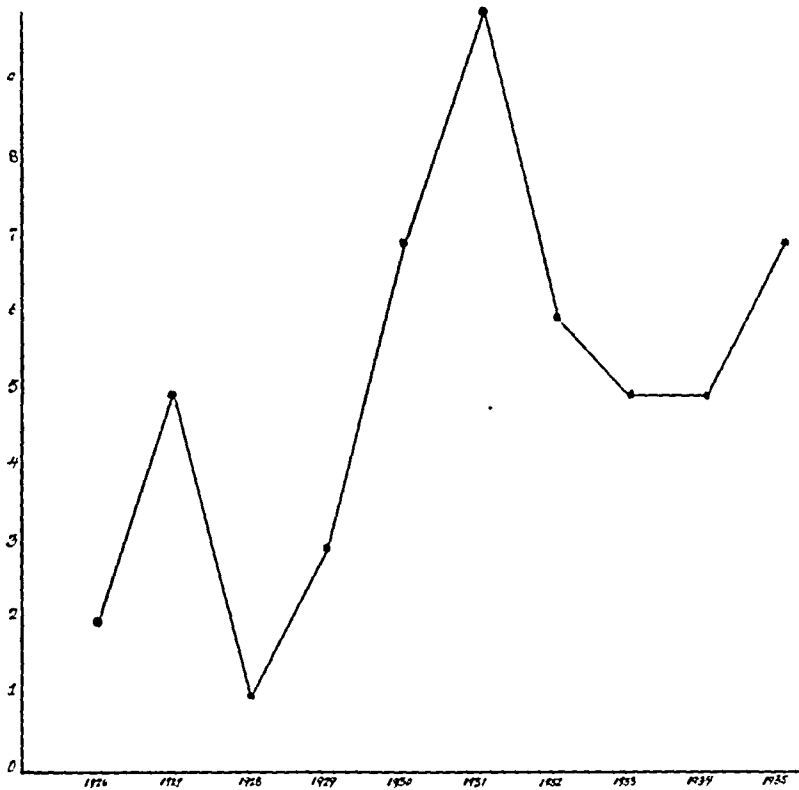


CHART 1. Distribution of 51 cases of pernicious vomiting of pregnancy over a ten year period. Note increase in annual total since 1929.

point of hyperemesis would mean complete review of the literature on the subject. It is sufficient to point out several fundamental facts.

Stander has demonstrated that the fetus, in the early weeks of pregnancy, gains most of its nutrition from the carbohydrates of the mother. Novak and Porges have demonstrated the tendency toward ketonuria, a manifestation of defective carbohydrate metabolism, in pregnant women. Titus and Vogt have proved the role of glycogen deficiency, and Duncan and Harding have shown the value of high carbohydrate feeding. In the exhibition of carbohydrates there rests an excellent clinical and therapeutic test of the value of the theory of inefficient carbohydrate metabolism.

The starting point of the metabolic derangement is traceable to carbohydrate

woman and the rapidly growing fetus. Deprivation of the mother by the fetus institutes an upset in the ketogenic-anti-ketogenic ratio. Clinically this is demonstrable in the prevention of "morning sickness" by high carbohydrate feedings immediately amenorrhea is reported. Similarly acetonuria may be prevented in the early months of gestation.

While we are satisfied that this theory explains the occurrence of "morning sickness," we are unable to account for the transition into hyperemesis. Since Williams' monograph in 1906 hyperemesis has been divided into three classes: (1) neurotic, (2) toxic, (3) reflex but we cannot subscribe to this classification. We have never seen reflex vomiting and no case in the present series has fit the original description. While we are familiar with the reported toxic vomiting, it has not appeared in this series

and these 50 cases have been derived from 24,000 obstetrical admissions. To all practical purposes, toxic vomiting is a rarity and probably in individual experience is very rarely seen.

With the neurotic classification of Williams we are in sympathy yet 25 per cent of our cases cannot be so listed. We are convinced from exhaustive study of case histories that *malinger* plays a powerful role in a goodly number of pernicious vomitors. This statement requires elucidation.

In the analysis of our histories in an attempt to seek the factors stimulating "morning sickness" we have had the assistance of one of the social service workers at The Harlem Hospital, who, for some time has been studying the economic and social background of many of the patients admitted to our service. From her we have learned that the terms "neurosis" and "hysteria" can never be made applicable to these patients as they are too burdened with responsibilities and the struggle for mere existence and subsistence. Unless one can conceive of a transient neurosis associated with pregnancy, or a hysteria originating concomitantly with early pregnancy, then these patients can never be regarded as neurotic pernicious vomitors.

Not only in the economically depressed patient does pernicious vomiting occur independent of neurotic origin, although the economic angle is important. We have seen a suggestive increase in cases since 1929. There are other factors which may stimulate emesis. The nulliparous woman bearing her first pregnancy may find many causes for pathomimesis, and tocophobia is of tremendous weight; the self-conscious patient offers numerous reasons; one example being the young, unmarried woman or the elderly patient finding herself pregnant with grown children surrounding her is another type; or the woman, recently delivered, who finds herself pregnant while still fatigued and convalescent from the first labor. In these patients who are seeking deliverance from the trials of childbearing and who turn to any means of escape,

there is no neurosis unless their very rational thinking is to be stamped as neurotic. Hyperemesis is beyond their reach yet by virtue of accentuation of "morning

TABLE I  
CASES REQUIRING INTERRUPTION OF PREGNANCY

| Onset of Nausea. (Days from Date of Last Menses) | Onset of Vomiting. (Days Following Onset of Nausea) | Duration of Vomiting before Intractability (in Days) | Duration of Intractability before Hospitalization (in Days) |
|--|---|--|---|
| 39   | 18  | 42   | 4   |
| 44*  | 8*  | 11*  | 13*   |
| Coincident with amenorrhoea                      |   |  |   |
| 39*  | 3*  | 75   | 13  |
|  |   | 5*   | Admitted on day intractability appeared.                    |
| 58*  | 7*  | 39*  | 20*   |
| Coincident with amenorrhoea                      |   |  |   |
| 37   | 6   | 32   | 18  |
| 41*  | 8*  | 6  | 9   |
| 48   | 7   | 21*  | 21*   |
| 46   | 7   | 20   | 4   |
| 33   | 2   | 7  | 7   |
| 39   | 0   | 2  | 2   |
| 39   | 5   | 21   | 9   |
| 34   | 8   | 17   | 13  |
| 37   | 0   | 14   | 11  |
| 58   | 6   | 8  | 6   |
| 35   | 8   | 2  | 9   |
| Average 36.7                                     | 6.1   | 20.1   | 9.9   |

\* Indicates fatality.

sickness" these patients may carry themselves to a point of starvation and inanition where the vomiting escapes them and they need no longer mangle. They ultimately attain to pernicious vomiting despite themselves. In them we readily find the mechanism of altering the primary metabolic disorder into hyperemesis.

In the true neurotic patient the mechanism remains unknown, though there is no question but that there is present a great psychic element. Too many of these patients have been cured by suggestion, isolation and the like to doubt the psychic influence.

We consider pernicious vomiting from two points of view: (1) the neurotic patient

in whom we have a history of personality defects or neurotic tendencies; and (2) the malingerer in whom self-induced starva-

TABLE II  
CASES MANAGED CONSERVATIVELY

| Onset of Nausea, (Days, from Date of Last Menses) | Onset of Vomiting. (Days, Following Onset of Nausea) | Duration of Vomiting before Intractability (Days) | Duration of Intractability before Hospitalization (Days) |
|---|--|---|--|
| 36  | 0  | 30  | 7  |
| 41  | 8  | 24  | 10   |
| 35  | 37   | 10  | 10   |
| 33  | 18   | 14  | 0  |
| 46  | 10   | 30  | 10   |
| 55  | 7  | 57  | ..   |
| 180   | ..   | 19  | 1  |
| 55  | 5  | 41  | 7  |
| 30  | 8  | 10  | 10   |
| 32  | 4  | 20  | 21   |
| 48  | 17   | 11  | 11   |
| 39  | 3  | 18  | 18   |
| 35  | 15   | 12  | 4  |
| 53  | 22   | 49  | 6  |
| 41  | 12   | 4   | 22   |
| 38  | 9  | 16  | 17   |
| 38  | 6  | 55  | 35   |
| 33  | 0  | 55  | 0  |
| 41  | 5  | 11  | 6  |
| 38  | 5  | 28  | 10   |
| 38  | 26   | 10  | 2  |
| 33  | 55   | 2   | 24   |
| 41  | 0  | 24  | 5  |
| 56  | 12   | 14  | 7  |
| 35  | 4  | 9   | 0  |
| 32  | 5  | 3   | 2  |
| 34  | 6  | 11  | 10   |
| 37  | 8  | 10  | 4  |
| 33  | 9  | 6   | 6  |
| 31  | 8  | 7   | 10   |
| 50  | 12   | 39  | 12   |
| 59  | 5  | 8   | 11   |
| 38  | 4  | 6   | 4  |
| 1 fatality under conservative management          |  |   |  |
| 67  | 18   | 24  | 24   |

tion has escaped influence and has produced the picture of inanition and its accompanying emesis.

**Laboratory Studies.** While in the management of these cases the usual laboratory routines were followed we briefly consider them here. Urinalysis always revealed acetoneuria and ketonuria. Further urinary studies were insignificant and non-pro-

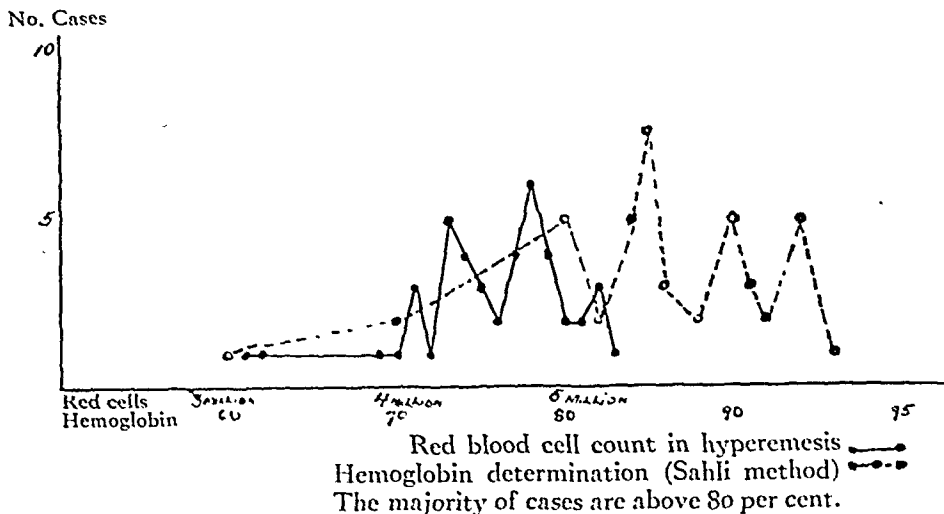
ductive. The blood chemistry findings duplicated previous work, moderately increased non-protein nitrogen and an occasional moderate decrease in blood chlorides, but we have never encountered the hypoglycemia, which Titus reports. We have never met with true acidosis, our findings agreeing with those of Dieckman and Crossen. We have never checked Van Wyck's findings, i.e., diminution in the serum protein and urobilinuria.

The blood counts of these cases presented a point of interest. Ordinarily there was a leucocytosis up to 12,000 white cells, with the increase chiefly in polymorphonuclear cells. The red cell counts and hemoglobin estimations showed evidence of blood concentration. The average red cell count in the patient admitted to our service approximates 4,000,000 cells with the average hemoglobin rarely above 80 per cent. From the following chart (11) it will be noted that in hyperemesis there is a tendency toward high red cell counts and high hemoglobin estimations. This blood concentration is common in conditions where there is a large and persistent fluid loss and is found in hyperemesis whether its origin is due to neurosis or malingerer.

**Clinical Considerations.** History. The accompanying tables indicate the manner in which we have sought to check on the relationship of intractable vomiting to duration. The cases are divided into two groups: those ultimately requiring interruption of pregnancy and those cured by conservative therapy. It will be seen that there is no existing relationship between the duration of vomiting and the ultimate occurrence of intractability. Several notable facts are derived from these tables which must be mentioned. Of this group of 50 cases, only 4 sought medical assistance in early troublesome vomiting and, of these, none was successfully controlled. These patients were treated at home and the most potent therapeutic agents employed were corpus luteum and sedatives. Forty-six patients sought no treatment until vomiting became intractable and in

this group were several whose vomiting persisted three weeks and longer before hospitalization was effected. Study of the

*Clinical Considerations.* Physical Findings. Considering, for the sake of brevity, the group of 50 cases as a whole, certain



## CHART II.

tables will indicate that there exists no relationship between the duration of in-

TABLE III  
RESPONSE TO THERAPY IN CASES REQUIRING  
INTERRUPTION OF PREGNANCY

| Pulse             |                  | Blood Pressure    |                  | Diuresis | Ketosis<br>(Urinary<br>Acetone) |
|-------------------|------------------|-------------------|------------------|----------|---------------------------------|
| Before<br>Therapy | After<br>Therapy | Before<br>Therapy | After<br>Therapy |          |                                 |
| 140               | 140              | 110/65            | 94/68            | None     | Negative                        |
| 120*              | 140              | 110/90            | 30/0             | None     | Positive                        |
| 100               | 110              | 114/90            | 94/64            | None     | Positive                        |
| 120*              | 120              | 122/80            | 84/40            | None     | Negative                        |
| 120*              | 130              | 94/68             | 84/60            | None     | Positive                        |
| 100               | 110              | 96/52             | 90/64            | None     | Positive                        |
| 126               | 138              | 100/80            | 90/68            | None     | Positive                        |
| 124*              | 134              | 90/48             | 80/0             | None     | Positive                        |
| 132               | 132              | 92/80             | 94/66            | None     | Negative                        |
| 122               | 120              | 100/60            | 90/78            | None     | Negative                        |
| 118               | 118              | 100/54            | 92/50            | None     | Positive                        |
| 140               | 140              | 86/48             | 88/48            | None     | Negative                        |
| 110               | 120              | 100/90            | 94/66            | None     | Positive                        |
| 80                | 100              | 110/60            | 128/70           | None     | Positive                        |
| 104               | 130              | 106/70            | 106/70           | None     | Positive                        |
| 120               | 160              | 90/60             | 88/46            | None     | Negative                        |

\* Indicates fatality.

tractability and fatal termination or between the duration of intractability and interruption of pregnancy.

The chief point is, that despite all the tremendous accentuation and publicity given to the advantages and desirability of prenatal care, in the vomiting of pregnancy, patients commonly avoid seeking assistance. We find, too, that in the rare exception that seeks advice, results are unsatisfactory.

findings on admission are of importance. In 49 the diagnosis of acetonuria was predicted from the odor of the breath. Every case, regardless of etiological classification, demonstrated dehydration by dryness of the tongue and mucosa. One patient was comatose on admission, one in acute mania and the rest were alert. Jaundice was present on admission in 7 cases, 2 of which terminated fatally. We have never seen jaundice develop in the course of hospitalization. Eleven patients vomited frank blood and in this group 3 fatalities occurred; one exhibited coffee-ground vomitus. Examination of the retina on admission or shortly thereafter revealed the presence of petechial hemorrhage in 5 cases. Four of the fatalities in the series were in this group.

In this group of cases the study of the occurrence of weight loss or emaciation has been of great interest. All these estimations have been approximate as we have had no means of an adequate check on the normal weight or the weight before pregnancy and the onset of disease. The graph (Chart III) indicates that there is a relationship between weight loss and ultimate case management. In 16 cases requiring interruption of pregnancy for cure of vomiting, the average weight loss was 13.6 pounds while in cases responding to conservative therapy the average weight loss was four pounds.

Only in 8 cases in a group of 34 treated successfully by conservative methods was the weight loss stated or evident. In addition

case therapeutic measures were unsuccessful. Despite the teachings and findings of numerous investigators, practitioners con-

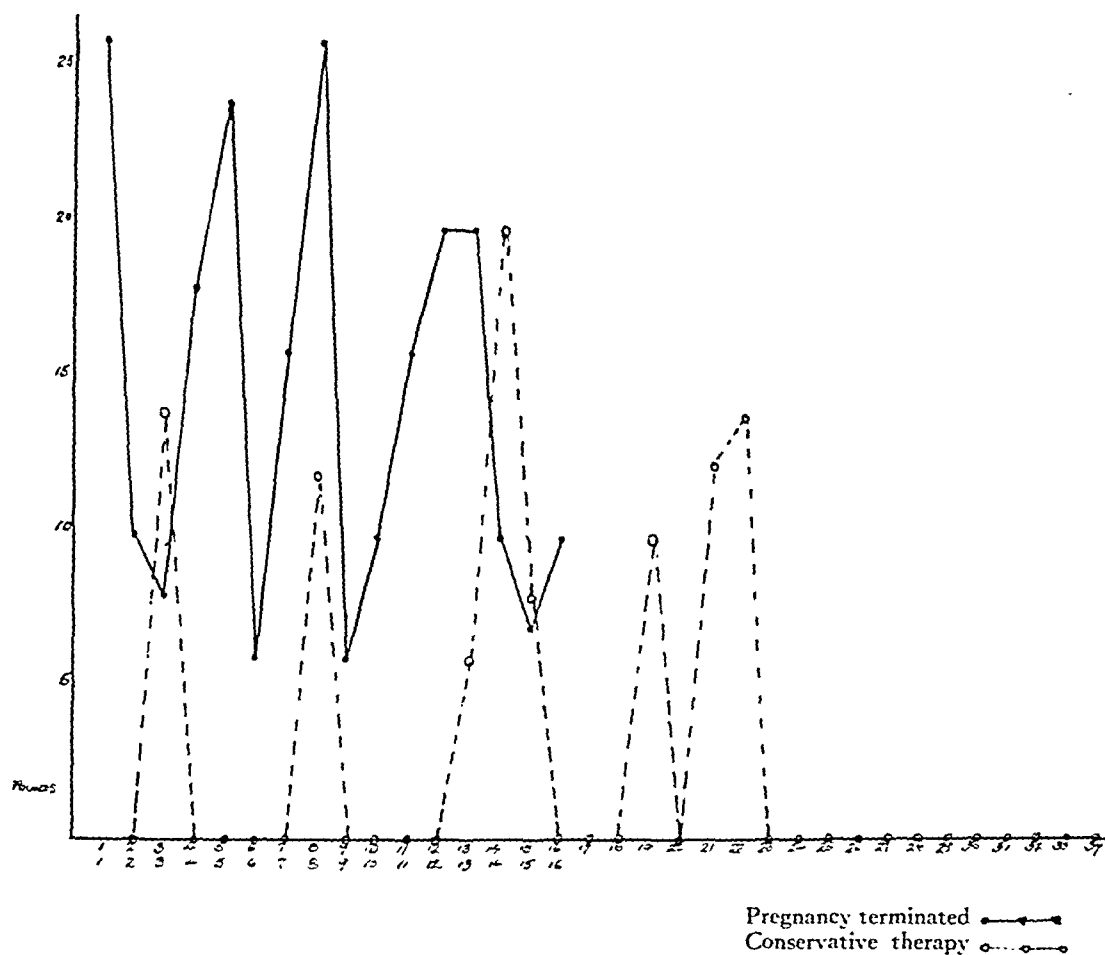


CHART III. Approximate weight loss in hyperemesis at time of admission.

|   |        |
|---|--------|
|   | Pounds |
| Average weight loss in interrupted cases.....                         | 13.6   |
| Average weight loss in cases responding to conservative therapy ..... | 4      |

to the story of the patient relevant to emaciation the patients were weighed on admission and during their hospital stay and clinical evidence of emaciation was sought.

We are forced, by the findings in this group, to the conclusion that weight loss is a definite sign of loss of reserve and that where there is advanced emaciation or evident large weight loss, conservative therapy will probably fail of its desired result.

**Therapy.** It has been stated in the foregoing that but 4 cases of this group sought treatment for vomiting and that in each

tinued to treat pernicious vomiting in the patients' homes. It cannot be emphasized too strongly that the first step in the successful management of any vomiting of pregnancy beyond the simple "morning sickness" is isolation. Early hospitalization will reduce the incidence of pernicious vomiting to an easily disregarded figure.

Every case admitted to our service had reached intractability. Tables III and IV, covering the duration of vomiting, indicate this. Because we feared radical management and because we have seen miraculous results under psychotherapy we have turned from the dictum of Kosmak

and routinized the first forty-eight hours of management in these cases as follows:

1. On admission elicit history and make a complete physical examination, including vaginal.
2. Obtain a catheterized specimen of urine and whole blood and blood serum for laboratory and chemical examinations.
3. Isolate the patient and every six hours administer 1000 c.c. of 5 per cent glucose intravenously, *covering all the glucose with requisite insulin.*

TABLE IV  
RESPONSE TO THERAPY IN CASES RESPONDING TO  
CONSERVATIVE MANAGEMENT

| Pulse                                    |               | Blood Pressure |                | Diuresis within Hours | Ketosis (Urinary Acetone) |
|--|---------------|----------------|----------------|-----------------------|---------------------------|
| Before Therapy                           | After Therapy | Before Therapy | After Therapy  |                       |                           |
| 80                                       | 80            | 125/80         | 114/90         | 24                    | Negative                  |
| 130                                      | 90            | 116/80         | 108/76         | 24                    | Negative                  |
| 110                                      | 86            | 144/80         | 122/80         | 40                    | Negative                  |
| 100                                      | 70            | 100/60         | 110/80         | 24                    | Negative                  |
| 90                                       | 90            | 96/60          | 108/84         | 24                    | Negative                  |
| 110                                      | 90            | 104/90         | 110/90         | 24                    | Negative                  |
| 90                                       | 80            | 108/84         | 120/86         | 18                    | Negative                  |
| 114                                      | 68            | 92/86          | 110/70         | 24                    | Negative                  |
| 106                                      | 86            | 98/70          | 120/86         | 36                    | Negative                  |
| 114                                      | 80            | 94/50          | 114/74         | 30                    | Negative                  |
| 98                                       | 68            | 100/86         | 120/84         | 48                    | Negative                  |
| 122                                      | 90            | 96/80          | 116/92         | 36                    | Negative                  |
| 128                                      | 80            | 98/48          | 128/90         | 30                    | Negative                  |
| 124                                      | 100           | 88/64          | 94/70          | 40                    | Negative                  |
| 118                                      | 86            | 90/56          | 110/84         | 36                    | Negative                  |
| 110                                      | 90            | 98/86          | 118/64         | 36                    | Negative                  |
| 112                                      | 88            | 90/66          | 106/74         | 48                    | Negative                  |
| 108                                      | 84            | 92/60          | 114/68         | 24                    | Negative                  |
| 110                                      | 90            | 90/50          | 106/78         | 38                    | Negative                  |
| 100                                      | 94            | 102/70         | 110/80         | 24                    | Negative                  |
| 98                                       | 82            | 86/50          | 120/90         | 48                    | Negative                  |
| 140                                      | 80            | 90/60          | 120/96         | 48                    | Negative                  |
| 120                                      | 80            | 100/90         | 134/88         | 24                    | Negative                  |
| 100                                      | 96            | 106/86         | 108/86         | 36                    | Negative                  |
| 80                                       | 70            | 118/70         | 118/70         | 36                    | Negative                  |
| 96                                       | 74            | 100/80         | 120/80         | 36                    | Negative                  |
| 108                                      | 72            | 94/86          | 110/78         | 48                    | Negative                  |
| 88                                       | 70            | 110/74         | 114/92         | 36                    | Negative                  |
| 90                                       | 84            | 130/74         | 128/90         | 48                    | Negative                  |
| 110                                      | 74            | 120/80         | 126/80         | 36                    | Negative                  |
| 130                                      | 84            | 116/64         | 128/96         | 30                    | Negative                  |
| 100                                      | 80            | 100/66         | 118/78         | 24                    | Negative                  |
| 98                                       | 80            | 100/82         | 132/88         | 36                    | Negative                  |
| 1 fatality under conservative management |               |                |                |                       |                           |
| 140                                      | 160-180       | 90/40          | Not measurable | 48                    | Positive                  |

4. Administer per rectum 3 grams of sodium and potassium bromide and 1 gram of chloral hydrate in 100 c.c. of distilled water.

5. Never remove infusion apparatus from the room.

6. Permit no visitors.

7. Permit nothing by mouth, this includes mouth wash. All mouth hygiene is to be performed by the nurse.

In every case this routine of therapy is followed for forty-eight hours. There is no indication for interruption of pregnancy upon admission. Such procedure is open to criticism and in the face of experience is unnecessarily radical. Many patients under the outlined routine quickly improve. The fact that when improvement is to occur it manifests itself within forty-eight hours is notable, but if at the end of such a period of rigorous adherence to the plan, there is no evidence of improvement, pregnancy should be interrupted. To delay interruption if there is failure of improvement is to risk the life of the mother.

Three signs of improvement have been found, totally disregarding the symptomatic picture. (1) The chief sign of control is diuresis, (2) the pulse rate and (3) the blood pressure. We find Pinard's dictum to be untenable but the rate of pulse and the estimation of the blood pressure under therapy are of great importance. In the improving patient there is always a drop in pulse rate and a rise in blood pressure; antithetical findings occur where there is no improvement. The tables clearly indicate these facts, and further and more significant, it is to be noted that all these signs make their appearance within forty-eight hours of the onset of therapy. Another sign of importance which we have not tabulated is hunger. This subjective manifestation makes an early appearance with favorable response and we attach considerable importance to it.

Previous to the routine usage of insulin considerable weight was placed upon the disappearance of urinary acetone bodies under therapy. The use of insulin deprives us of this sign of advance yet, in contradistinction to Dieckman and Crossen, Harding and VanWyck, Campbell and Macleod, we concur with Thalhimer that relief and improvement are obtained more quickly with the routine administration of insulin. We feel that the sacrifice of the sign of

improvement is a fair exchange for the evident clinical advantage gained.

These conclusions have been drawn from a study of the response to therapy in this series of cases:

1. Response to therapy, if it is to occur, appears within forty-eight hours.

2. The chief indications of response are diuresis, slowing of the pulse and elevation of the blood pressure. The improving patient complains of hunger.

3. The clearing of urinary ketone bodies is not to be relied upon if insulin is employed in treatment.

4. When diuresis does not appear within forty-eight hours, the pulse rate increases and the blood pressure falls.

5. When these signs do not appear within forty-eight hours the immediate interruption of pregnancy is indicated.

#### INTERRUPTION OF PREGNANCY

When conservatism has failed, interruption of gestation carries a possibility of cure and when properly timed the results are invariably satisfactory. It must be recalled, however, that this disease has gained a firm foothold and that happy end results cannot always be expected. In this series of cases there were 5 deaths, a mortality of 10 per cent which should warn against prolonged delay of radical procedures.

The choice of procedure and anesthesia are important. The condition of the patient generally militates against any procedure which carries with it trauma or prolonged subjection to anesthesia. The method of emptying the uterus usually is related to the period of gestation; at eight weeks the curet is preferred, and between eight and fourteen weeks the placental forceps, in gestations beyond fourteen weeks vaginal hysterotomy is the method of choice. Regardless of the method of determining the procedure, it is sufficient merely to disturb the gestation with the least trauma and greatest speed. In the seriously ill patient the cervix is dilated and the curet is used until placental tissue is carried from the uterus or the membranes are ruptured.

A strip of iodoform packing gauze is left in the fundus and supplemented by snug, vaginal packing will accomplish the completion of the abortion. It is illogical and unsurgical to submit these patients to hysterotomy or fundectomy. In this series 13 pregnancies were interrupted by dilatation and curettage; 2 were managed by the insertion of a bougie and fundectomy was performed once but this last patient had an exceedingly stormy postoperative course.

We have made it almost routine to transfuse these patients shortly before or during the operative procedure as their condition is so poor that their resistance to infection is practically nil and we do not permit them to undergo blood loss of any volume.

Careful choice of anesthesia is important. Since there must be no added burden, it is better that ether, chloroform and ethylene are avoided. Intravenous anesthetics, depending as they do upon normal hepatic function for their margins of safety, should not be used. The anesthetics of choice are spinal and nitrous oxide gas and oxygen. We used the latter 14 times and spinal in the remaining 2 cases.

*Supplemental Therapy.* To consider the battle won when the uterus is emptied or with improvement at the end of forty-eight hours of conservatism is to invite disaster. Fluids must be forced parenterally for at least seventy-two hours and preferably for ninety-six hours. When hunger has replaced nausea and vomiting as the chief complaint, feeding may be begun, but cautiously and gradually and should *not be started with liquids*. We begin feedings with teaspoonful rations of thick, dry cereals and never with more than one such dose per hour, later adding a banana mash in a similar dosage. The combination of thick cereal and bananas is continued for twenty-four hours before small amounts of fluid are added. These should never be cold nor should fruit juices or milk be used, warm water or tea being better tolerated. At the end of seventy-two hours of this regime a minimal light diet may be instituted and the normal diet gradually re-

stored over a period of ten days. Particularly in the conservatively successful case must this be followed, since relapses are prone to occur. This has happened twice in this series.

*Necropsy Findings.* Necropsy was obtained in only one of the 5 deaths in the series. The pathologist's report was of no great moment, the findings presented were characteristic of dehydration and starvation. The central necrosis in the hepatic lobules was not in evidence.

*Significant Findings.* This analysis proved a disappointment from the point of view of discovering clinical signs of infallible nature. We feel safe, however, in suggesting certain facts; in the presence of marked emaciation it may be the wiser procedure to proceed to interrupt the pregnancy without any trial at conservatism; hemorrhagic retinitis is a grave sign and there should be no dalliance with such cases. Where conservative treatment is instituted it should be allowed forty-eight hours to produce perceptible improvement.

#### CONCLUSIONS

A series of 50 cases of hyperemesis gravidarum is presented and analyzed.

The mortality for the series is 10 per cent, but the rarity of the disease is no justification for the mortality it carries.

Prenatal care has not yet reached to the earliest months of pregnancy and in consequence a controllable situation is escaping notice and is developing into a grave obstetric entity.

The patient must be educated to the fact that vomiting is dangerous and controllable and the practitioner must be urged to treat his cases in hospitals.

Radicalism immediately upon hospitalization is not justifiable but delay in interrupting the pregnancy should not be

postponed beyond forty-eight hours of rigorous conservative therapy.

Pulse rate, blood pressure and diuresis are the best indicators of the effect of therapy. To disregard the warnings of the pulse rate and the blood pressure is only an invitation to disaster.

There is no absolute clinical guidepost to interruption of gestation.

Isolation and fluids are the chief agents in therapy.

The hospitalized patient is at the stage of intractability, best indicated by emaciation and by the concentration of the blood evident in red cell determinations and hemoglobin estimations.

The old classification of hyperemesis is no longer tenable and notice must be taken of the malingerer in whom there occurs an escape of pathology from voluntary control.

We must express an infinite gratitude to Miss H. Hotchkiss of the Social Service Department of The Harlem Hospital for her studies of the economic and social status of many of the cases here reported and for her fresh point of view on the role of neuroses in these women.

#### REFERENCES

- DIECKMAN, W. J. and CROSSIN, R. J. *Amer. Jour. Obst. and Gynec.*, 14: 3-29 (July) 1927.  
 DUNCAN, J. W. and HARDING, W. J. *Can. Med. Assn. Jour.*, 8: 1057-1069 (Dec.) 1918.  
 HARDING, W. J. and VANWYCK, H. B. *Amer. Jour. Obst. and Gynec.*, 11: 1-9 (Jan.) 1926.  
 HIRST, J. C. *Jour. Amer. Med. Assn.*, 76: 772-773 (March 19) 1921.  
 TITUS, P. and DODDS, P. *Amer. Jour. Obst. and Gynec.*, 16: 90-96 (July) 1928.  
 VANWYCK, H. B. *Tr. Sect. Obst., Gyn., and Abd., Surg.*, 43: 125-131, 1930.  
 WILLIAMS, J. W. *Johns Hopkins Hosp. Bull.*, 17: 71, 1906; *Jour. Obst. and Gynaec., Brit. Emp.*, 22: 245, 1912.  
 LEATNES. *Proc. Roy. Soc. Med.* (March) 1908.  
 PECKHAM. *Amer. Jour. Obst. and Gynec.*, 17: 776-788, 1929.  
 STANDER, H. J. *Am. Jour. Obst. and Gynec.*, 13: 551-563 (May) 1927; *Toxemias of Pregnancy*, Baltimore, Williams and Wilkins Co., 1929.  
 THALHEIMER, W. *Jour. Amer. Med. Assn.*, 82: 696-699 (March) 1924.





# HELPFUL DRUG IN TREATMENT OF TUBERCULOSIS OF URINARY BLADDER

JOHN T. BATE, M.D., F.A.C.S.

LOUISVILLE, KY.

COPEMAN published an article in the *British Medical Journal* on the use of fluorescein activated by x-ray therapy, in cases of cancer. From this suggestion Goulesborough<sup>1</sup> was led to instill two ounces of 5 per cent fluorescein into the tuberculous bladder of a patient and then use x-ray therapy. Walker<sup>2</sup> followed his technique in one case with some improvement of his patient.

Having under our care a single, white woman of forty-four years of age, who had the distressing bladder symptoms of frequency, nocturia and pain, with tubercle bacilli coming from both kidneys as proved by repeated positive guinea-pig tests, but only slightly abnormal pyelographic and functional findings, we explained the experimental nature of the treatment and she requested that it be instituted.

A 5 per cent solution was made by dissolving the acid fluorescein in water made alkaline by means of sodium bicarbonate. Two ounces were instilled into the bladder and roentgen ray therapy given. Although the incipient menopause was hurried to completion, she reported more relief than from any of the myriad of other treatments tried.

Subsequently two ounces of the alkaline fluorescein solution was instilled into bladder and left for half an hour but no roentgen ray therapy was used. Following this she reported nocturia once, and less pain and frequency during the day. Accordingly we were led to wonder whether or not the benefit was largely or possibly entirely due to the medication rather than to the roentgen rays acting in conjunction with the fluorescent chemical.

Experimentation with guinea-pigs showed that the acid fluorescein put into solution with sodium bicarbonate,

was not only irritating to tissue but also destructive when injected subcutaneously, leading to slough and death. Accordingly we tried various fluorescein derivatives, determining that sodium fluorescein by mouth seemed non-toxic when given to guinea-pigs in large doses over a long time.

A twelve year old white female, whose father died of pulmonary tuberculosis and whose right kidney had been removed for tuberculosis, continued to have severe bladder symptoms, voiding every fifteen minutes during the day and so frequently at night that she obtained little rest, and even wet the bed repeatedly every night between trips to the toilet. Trial of the alkaline fluorescein solution was made. As roentgen therapy could not be used because of the destructive effect on the ovaries, we were delighted to hear that she considered herself benefited after each treatment. The instillations were painful, even when used following an instillation of a mucous membrane anesthetic agent, so we were led to try sodium fluorescein by mouth.

As this chemical was not available from apothecaries, it was obtained in bulk and two grain capsules filled. Starting cautiously the dose was gradually increased until the older woman took eight capsules daily and the girl six. Both reported great relief which became progressively more complete with the passing of time. The urine was definitely fluorescent, the intensity varying with the quantity of drug taken by mouth.

The girl showed no deleterious symptoms at any time, though she was not very faithful in taking medicine. After about nine months of treatment she said that she did not have any nocturia and did not

wet the bed. Cystoscopy eight months after the treatment had been started showed great improvement in the bladder, though the bas fond portion was still definitely involved. Urine of the apparently normal kidney and from the bladder was injected into guinea-pigs at this time. The pigs did not develop tuberculosis.

Cystoscopic examination of the woman performed eighteen months after treatment by instillation was started and ten months after treatment by mouth was started, showed a greatly improved bladder. The mucous membrane was nearly of normal color, did not bleed and was not unduly irritable. The left ureteral orifice appeared normal, the right orifice was slightly reddened. Urine from each kidney was clear and negative for tubercle bacilli, though a few pus cells were present. The right pelvis was slightly dilated with slight irregularity of one lower minor calyx and the left still showed a minor calyx at the upper pole which suggested irregularity. If there was any change, this minor calyx appeared more normal. If it represented a diseased area, it certainly had not progressed.

At this time, i.e., eighteen months after starting fluorescein therapy, she does not seem to be as completely relieved of the frequency as she was for the first year, though the bladder appears more normal than it ever has before.\*

A guinea-pig was injected with her urine at the start of the treatment. After three weeks it showed definitely tubercular induration in the mammary region. Treatment of the pig with sodium fluorescein was instituted, approximately eight grains being given by mouth daily. This pig was

\* Twenty-two months after fluorescein treatment was started, the woman who had bilateral renal tuberculosis developed more severe bladder discomfort. Pyelograms showed that the right kidney had become definitely tuberculous, while the left kidney seemed normal. The guinea-pig inoculated with urine from the left kidney was now negative though it had previously been positive repeatedly. The right kidney was removed. The patient is now practically well. Post-operatively she had a great deal of bladder pain, frequency and dysuria. Fluorescein instillations followed by a small dose of radiation, benefitted this greatly.

pregnant and later gave birth to four young, two of which were dead and two feeble. Although caseation occurred in the mammary region, no ulcer developed, though some pus may have been discharged at some unknown time. The pig improved in weight and appearance. Six months after infection, it was apparently in fairly good health except for the large nodular area in the left mammary region. After seven months it again began to lose weight and died within two weeks of generalized tuberculosis.

A pig of similar size was injected with the woman's urine after she had been under this treatment for one month. Four weeks later it developed a nodule which progressed more slowly than that of the first pig. It failed progressively and died four months after injection, from generalized tuberculosis.

A pig was injected with the urine of the girl. This pig developed a nodule in the mammary region 1 cm. in diameter. The pig was given fluorescein. The nodule did not enlarge and the pig remained in fairly good health until seven months had passed when it died suddenly. Autopsy was not done because of failure to obtain message of pig's demise.

Two small pigs were injected with a known virulent tubercle bacillus (H 63 Saranac virulent human type), which had been inoculated into normal saline containing about the same amount of fluorescein as the urine of a patient receiving about ten grains daily of sodium fluorescein. This was estimated grossly by matching the colors. In the first case the germs were exposed to the fluorescein for twenty-four hours; in the second forty-eight hours.

A third large healthy pig was injected with the germs after exposure to the fluorescein for seven days.

The first two pigs died after the lapse of three and one-half months, one having been treated with sodium fluorescein and one not having been treated. The treated pig died two days before the untreated one. Both had generalized tuberculosis, proved at autopsy. The third pig developed

a small nodule about 7 mm. in diameter, after a month. This slowly disappeared and the pig remained in excellent health.

Recently, after nearly seven months this pig has developed an enlarged lymph gland on the side of infection. It does not have the consistency of a tuberculous node, and the pig is in good health.

Another large pig has been carried as a control, being given sodium fluorescein in large doses (10 to 20 grains daily by mouth) for eighteen months. It has remained in apparently perfect health. The medication is being continued in order to determine whether or not it will show any evidence of injury from long continued daily administration of sodium fluorescein.

A fourth pig was injected with 2 c.c. of the woman's urine after she had been treated with fluorescein for six months. A small induration developed in the muscles of the abdominal wall three weeks later. This diminished in size slowly until it disappeared.

From the foregoing observations, it seems clear that sodium fluorescein when taken orally, gives some symptomatic relief to sufferers from tuberculosis of the bladder secondary to infection of the kidney. When an alkaline solution of fluorescein is used as an instillation in the tuberculous bladder, it gives symptomatic benefit. It seems possible sodium fluorescein has some slight bacteriostatic effect on the tubercle bacillus, though this is not enough to warrant much hope. This is supported by the clinical improvement of the 2 patients, which consisted of gains in weight in both, subsidence of afternoon temperature in one and the healing of a sinus in one; also by the fact that the pigs which were infected with urine from these patients and then treated with sodium fluorescein survived a longer time in apparent fair health than the untreated control. Of the 3 pigs injected with a known virulent human strain, the 2 pigs which were treated died without showing much capacity to localize the infection. The third, in which the organisms

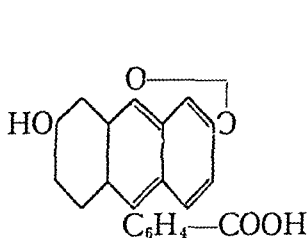
which were exposed to sodium fluorescein solution for seven days were injected, was untreated yet has survived apparently having healed an initial infection.

Benefit appears so promptly after commencing medication, that we are led to believe the fluorescein exerts a soothing action on the mucous membrane and possibly an antispasmodic on the sympathetic nervous system.

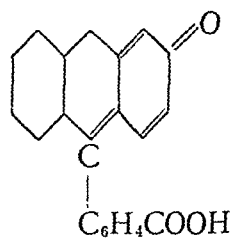
We realize that our inadequate facilities prevented the use of a large enough number of carefully controlled animals and patients to make this conclusive, but we do feel that the findings are interesting, suggestive and very helpful.

#### HISTORY AND PHARMACOLOGY

Fluorescein was first prepared by Baeyer in 1887 by fusing a mixture of phthalic anhydride and resorcinol. He gave the formula  $C_{20}H_{12}O_5 + H_2O$  to the yellow product precipitated from alkaline solution by acids, while to the dark red powder crystallized from ethanol he gave the formula  $C_{20}H_{12}O_5$ .

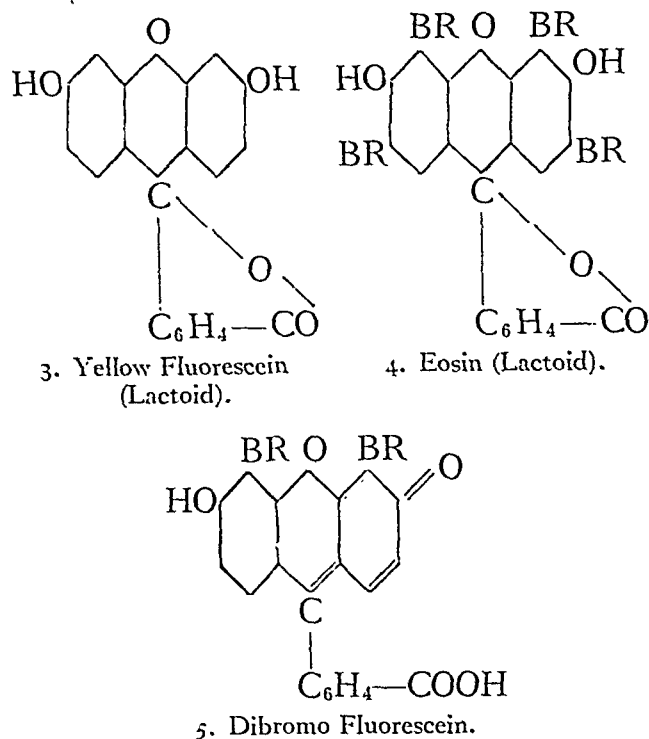


1. Fluorescein (o-quinoid).



2. Fluorescein (p-quinoid).

Investigations show that fluorescein exists in two forms, red and yellow, they being isomeric and having formula  $C_{20}H_{12}O_5$ . The yellow form is obtained by precipitating an alkaline solution of fluorescein with acetic acid at room temperature. The red form is obtained by precipitating a boiling, alkaline solution of fluorescein with acetic, formic or hydrochloric acid. It is believed that the yellow form of fluorescein, despite its color, has a lactoid structure (III) and that the red form has the P-quinoid structure (II).



Fluorescein (resorcinolphthalein, dioxy-fluorane, diresorcinolphthalein) is a red, crystalline powder, soluble in alkaline solution, at which time it is red by transmitted light. In weaker dilutions it has a bright green fluorescence. It is soluble in boiling dilute acids, alcohol, hot glacial acetic acid; it is insoluble in water, benzene, chloroform and ether. It is decomposed by heat above 290 degrees without melting. Employing a solution made from grain  $7\frac{1}{2}$  fluorescein, grain 15 sodium bicarbonate and one fluid ounce of water, it is used to aid in the detection of foreign bodies imbedded in the cornea, the diagnosis of corneal lesions and impervious strictures of the nasal duct. It is also used as an indicator and as a test for renal function, to determine actual death, and also, in the same ways as fluorescein.

#### LITERATURE

Strauss reported an investigation with sodium fluorescein used to estimate kidney function. Durand and Hugenin found that it still exhibited fluorescence when diluted 1:2,000,000. Ehrlich<sup>6</sup> introduced it into physiology in 1882, while studying the aqueous humor in animals. Hamburger<sup>7</sup>

has reported that its amount in the aqueous humor of man is changed by the presence or absence of inflammation in the ciliary body. He gave doses of six to eight grams to adults and found no harmful after-effects, even when the dose was increased to fifteen grams. The only effect is a more or less yellowish coloring of the skin, which, with smaller doses disappears within eleven or twelve hours. In the larger doses the coloring disappears after twenty-four hours. The saliva and tears were colored green. The color of the urine was retained longer than that of the skin.

Strauss<sup>5</sup> gave fluorescein to 30 patients for kidney function tests. The fluorescence is equally visible in alkaline and acid reactions. No untoward accessory effects were seen. In patients with kidney disease, elimination was late in appearing and continued more or less past a forty hour period.

Hamburger<sup>7</sup> found subcutaneous injections painful. Guinea-pigs will tolerate a subcutaneous injection of sodium fluorescein in dilution but a dose of one gram causes a slight polyuria. One gram is a large dose for children.

In a case of carcinomatous peritonitis, a diffusion of the dye in the ascitic fluid was shown. It has also occurred in the ascitic fluid of dogs who have artificial nephritis.

In studies on the sources of the aqueous humor of the eye, Ehrlich<sup>8</sup> used ammonium fluorescein. When injected subcutaneously in concentrated doses it caused pain. The beautiful fluorescence enabled him to see the anterior chamber of the eye fill with aqueous humor in five to six minutes after the drug was administered to rabbits. He showed that a minute amount will cause fluorescence in the blood. He found no toxic or untoward effects in experiments with animals, although huge doses were used. It seemed probable that as Krosta suggested, in spite of the drug's apparent physiologic indifference, it had a slight definite mydriatic effect.

The possible mydriatic effect raises the question as to whether or not part of the beneficial effect we have noted in the bladder may be due to lessening spasm. We believe the effect is more profound than this and depends on the tendency of the fluorescein to localize in injured or diseased tissue and there exert an inhibitory effect on lower forms of life such as the tubercle bacilli.

In taking venous blood for chemistry, it was interesting to note that it was fluorescent enough to interfere with the mercury combining method of doing blood urea by the Hench and Aldrich method.

Raffo and Calcagno<sup>9</sup> found that while chlorine and iodine substitution products of fluorescein were hemolytic, the fluorescein itself was not and bromine products only slightly.

Tappeier and Raab<sup>10</sup> (1903) have found that fluorescent substances are very destructive to all forms of life, and also to ferments and toxins; but that the effects appear only in the presence of the specific light rays which induce the fluorescence. Toxins are very susceptible to fluorescence (Noguchi,<sup>11</sup> 1906).

The use of ultra-violet irradiation as an adjunct therapy may be of some benefit, but it is not necessary in order to obtain the symptomatic result.

## CONCLUSION

Sodium fluorescein taken by mouth gives some symptomatic benefit to patients suffering from tuberculosis of the bladder secondary to tuberculosis elsewhere. It seems possible that it has some slight bacteriostatic effect on the tubercle bacillus.

I want to thank Dr. Leroy W. Gardner of the Saranac Laboratory for supplying me with the cultures of tubercle bacilli.

## REFERENCES

1. GOULDESBOROUGH. *Brit. Med. Jour.*, 1931.
2. WALKER, K. *Brit. Jour. Urol.*, 4: 340, 1932.
3. ORNDORFF, W. R. and HEMMER, A. J. *Jour. Am. Chem. Soc.*, 49: (Jan.-July) 1927.
4. MERCK'S Manual.
5. STRAUSS, H. Fluorescein als Indikator für die Nierenfunktion. *Berl. klin. Wchnschr.*, 50: 2226, 1913.
6. EHRLICH, P. Ueber Provozierte Fluoreszenzerscheinungen am Auge. *Deutsch. med. Wchnschr.*, 2-4: 1882.
7. HAMBURGER, C. Ueber des Farben lebender menschlicher Augen zu physiologischen und diagnostischen Zwecken. *Ber. klin. Wchnschr.*, 30: 1909.
8. EHRLICH, P. Ueber provocierte Fluoreszenzerscheinungen am Auge. *Deutsch. med. Wchnschr.*, 8: 21, 35, 54, 1882.
9. RAFFO, A. H. and COLCAGNO. Los derivados de la fluoresceina y su accion las hematias de sangre de animal normal y en tumor. *Bol. inst. del cancer*, 8: 595-643, 1931.
10. TAPPEIER and RAAB. Fluorescence. *Ergebn. d. Physiol.*, 8: 698, 1909.
11. NOGUCHI. Saponin. *Jour. Exper. Med.*, 8: 268, 1906; Toxins, *ibid.*, 8: 263, 1906 (quoted by T. Sollmann, Manual of Pharmacology).



# FACTORS OF IMPORTANCE IN REDUCING MORBIDITY AND MORTALITY FOLLOWING OPERATIONS ON BILIARY TRACT\*

CALVIN M. SMYTH, JR., M.D., F.A.C.S. AND JAMES B. MASON, M.D., F.A.C.S.

PHILADELPHIA

A TREMENDOUS literature dealing with cholecystic disease in all its phases has developed during recent years, with many valuable and specific contributions being made by Judd, Mann, Graham and others. However, reports treating of methods and points of technique which are employed or developed in various clinics would seem to be of sufficient importance to warrant inclusion in the literature of gall-bladder disease.

A perplexing problem and one which always calls for nicety of judgment is the management of acute cholecystitis. Those surgeons who advocate immediate operation cite among the hazards of delay, complications such as perforation, peritonitis, extension of infection to the ducts and pancreas, pulmonary involvement and the overburdening of a damaged heart by toxemia. These are obviously manifestations of infection and their incidence is claimed to be reduced through immediate operation. Opposed to the practice of immediate surgical intervention are those surgeons who, from a wide experience, believe that the gall bladder rarely perforates into the general peritoneal cavity and that the ability of the gall bladder to overcome and localize infection has been underrated. Positive cultures have been obtained in approximately 75 per cent of our cases of subacute and chronic cholecystitis since we adopted the procedure of placing a piece of gall-bladder wall in a culture tube of glucose brain broth at the operating table (technique of Eiman<sup>1</sup>). Judd, Nickel and Wellbrock<sup>2</sup>

have previously reported similar results. It has long been known that a gall bladder once infected remains so. An exception to this rule is the acute catarrhal gall bladder in which the submucosa has not been invaded.

If it were possible to get the average case of acute cholecystitis to the surgeon as promptly as, for example, the average case of acute appendicitis, the situation might be different, but very few surgeons actually see many early acute gall bladders. The practitioner does not send these cases to the surgeon at once, but treats them medically for several days. This may be our fault. At the Methodist Episcopal Hospital which cares for a large Italian population, gall-bladder disease is very common. Most of the cases seen have been ill for three or four days. Operation undertaken at this time certainly can not be termed "immediate" and it is questionable as to whether or not it can even be termed "early."

The complications which in our experience are most apt to occur following operation for acute cholecystitis and against which it is the surgeon's duty to fortify his patient, are failure of hepatic, renal and cardiac functions and hemorrhage; not perforation, peritonitis and their sequels. Adequate protection against these requires time, in some a shorter period than others. The question is not, "Can we get away with immediate operation?" but should we try to do so if by so doing we deprive the patient of the maximum protection to which he is entitled.

<sup>1</sup> EIMAN, JOHN. Personal Communication.

<sup>2</sup> JUDD, E. S., NICKEL, A. C. and WELLBROCK, W. L. A. The association of the liver in disease of the biliary

tract. Collected papers of the Mayo Clinic and the Mayo Foundation. Phila., W. B. Saunders Co., 1930, pp. 84-90.

\* From the Department of Surgery, Methodist Episcopal Hospital, Philadelphia, Pa.

Almost every surgeon of experience is able to point to brilliant results in cases where, on a diagnosis of some other acute abdominal condition, he has operated at once only to encounter an unsuspected acute gall bladder. It is true that these experiences make us pause and think, and doubtless it is this which has been responsible for the conversion of many surgeons to the practice of early attack. However, in many hospitals the majority of acute abdominal emergencies are operated upon by junior members of the surgical department. If we come to regard acute cholecystitis in the same category as acute appendicitis, strangulated hernia and other forms of acute intestinal obstruction, etc. the mortality is apt to be appalling.

It has been our practice to treat these patients with acute cholecystitis by placing them in the semi-Fowler position, washing out the stomach if vomiting is a prominent feature, withholding everything by mouth except small amounts of hot liquids, glucose by vein (1000 c.c. of 10 per cent per diem) and normal salt solution by hypodermoclysis. A small enema is usually given on admission and morphine is used rather liberally. If, under this plan, the patient shows continued improvement as to pain, fever, etc., he is allowed to go on improving and operation is deferred until fever has been absent for about a week, when cholecystectomy is done as the operation of choice. One reason for waiting in these cases is that cholecystectomy can be safely undertaken in patients who, operated upon during the height of their symptoms, could stand only cholecystostomy which is at best an unsatisfactory procedure, only to be done when the more formidable operation is unsafe. It is a compromise between adequate surgery and temporization. In the gall bladder that has become partially gangrenous and in which cholecystostomy obviously will not answer, Jopson practiced, what he termed subtotal cholecystectomy, with great success. The fundus of the gall bladder was amputated as far

down as possible without extensive manipulation and a small tube sutured into the stump. This operation is not as shocking as complete removal of the gall bladder but is infinitely superior to simple drainage.

We do not infer by the foregoing statements that we never resort to immediate operation in acute gall-bladder disease. If seen at the onset and if there is no obvious contraindication, or if the case seen later does not show improvement under the waiting plan, particularly with increasing pain and tenderness, operation is done at once. In these patients our results from the point of mortality and morbidity have been gratifying.

The surgeon must have adequate and responsible advice from the internist on many phases of cholecystic disease. The diagnosis, presence of complicating lesions of the heart, lungs, kidneys or diabetes, and the manner in which they will or will not adversely affect the subject of a proposed gall-bladder exploration are duties of the medical man to appraise and inform the surgeon. The decision to operate must remain in the province of the surgeon for it is his responsibility and his alone.

The addition of intravenous glucose to the pre- and postoperative management of gall-bladder cases has been of incalculable value. Where an elective operation is to be done our patients are given 500 c.c. of orange juice to which are added 50 grams of sugar during each twenty-four hours, unless the stomach will not tolerate it. This we have found to be a very efficient means of increasing the glycogen reserve. In addition glucose is given intravenously in amounts of 500 to 1000 c.c. of 5 per cent solution either in distilled water or normal saline depending upon the blood chloride content. Since we have followed this plan the postoperative morbidity, particularly as regards vomiting, has been greatly reduced. In a group of 272 postoperative gall-bladder patients, allowing one emesis during recovery from anesthesia, those individuals who had been so prepared showed an incidence of vomiting of 3.5 per

cent. In another group of this series not receiving glucose 52 per cent vomited two or more times and a few suffered persistent vomiting for short periods. The application of the suction drainage of Wangenstein, withholding fluids by mouth, and post-operative intravenous glucose and saline usually give prompt relief from this complication. A safe rule is to allow these patients nothing by mouth for the first twenty-four hours.

Surgical technique presents an opportunity for a discussion of certain procedures which in our opinion are helpful in promoting a smooth convalescence. Adequate incisions of the Bevan or Mayo-Robson type allow a good exposure of the structures of the biliary system. There is no question of the value of ample room against cramped space associated with strong retraction of the abdominal walls for lowering postoperative morbidity. The surgeon knows that wounds heal from the sides and not from the ends. The appendix should be examined and if its removal is indicated no attempt should be made to deliver the cecum through the original incision if this presents any difficulty. It is much better to make a small gridiron incision immediately over the cecum. Other things being equal, rapidity of operation is an important factor. This, together with better control of the cystic artery and duct, is facilitated by adequate incision. Disaster in the form of hemorrhage, injury to the common duct and trauma to other tissues has crept in through many a "button-hole" type of incision.

Once the incision has been made the packing off becomes important and it is remarkable that many surgeons perform this step in a most casual or haphazard manner. Two or three large packs are necessary; one carries the stomach and duodenum to the left, a second displaces the colon downwards and a third may be necessary to prevent loops of small bowel from intruding. Packing off in this manner permits of easy access to the gall bladder and ducts without recourse to strong

retraction. We prefer the large gooseneck retractor of the Deaver type for this part of the operation.

Individual isolation of the cystic duct and cystic artery have much to do with proper ligation of each of these structures. Each is isolated, clamped, cut and ligated. A useful maneuver is for the first assistant to support the clamp and with a long finger forceps with the first knot loosely tied, carry the ligature over the end of the clamp. The surgeon tightens the knot and the assistant, when directed, removes the clamp. A second and third knot may be applied by the operator. With this technique we have rarely been bothered by hemorrhage incident to removing the clamp.

When the common duct requires exploration and drainage an "L" catheter is sutured in place for periods up to three weeks; for longer periods the T-tube is preferred. We agree with Judd<sup>2</sup> that if the common duct requires opening it should not be closed primarily. Prolonged drainage has a very beneficial effect upon the congested liver and upon chronic pancreatitis. This type of drainage may be maintained for weeks or even months. We have frequently allowed a T-tube to remain for six months and one patient wore a tube for four years.

Regarding drainage we believe that a drain should always be inserted and that contrary to the experience of others, hernia is unlikely, especially when the drains are brought out through a lateral stab wound. The patient is spared the complications following slipping or premature absorption of a ligature, or leakage of bile from an unnoticed accessory duct. Prolonged drainage is unnecessary. We usually employ only a small drain of the Penrose type which is loosened on the fourth day, removal being completed on the sixth or seventh day. If there has

<sup>2</sup> JUDD, E. S., NICKEL, A. C. and WELLBROCK, W. L. A. The association of the liver in disease of the biliary tract. Collected papers of the Mayo Clinic and the Mayo Foundation. Phila., W. B. Saunders Co., 1930, pp. 84-90.



been much bleeding an additional small rubber tube is placed in the subhepatic space. In this case the Penrose drain is removed in forty-eight hours and the tube shortened one inch a day beginning on the fifth day.

Save in a few cases of acute cholecystitis or the acutely ill or very old patient with chronic cholecystitis, cholecystectomy has been the procedure in all cases. The stoneless gall bladder which causes indefinite symptoms and which concentrates dye well should receive medical management. However, the stoneless gall bladder which

gives rise to dyspepsia of the biliary type had best be removed if the patient is to be cured. Cholecystography in these cases is not a completely reliable guide. Often these organs are the seat of cholesterosis and will show function superior to the normal organ but they cannot be considered free of disease.

In all matters pertaining to the management of gall-bladder disease judgment is the essential factor. It is a product of experience which should be able to guide the surgeon in arriving at that decision which will best serve the interests of the patient.



TILTING the patient one way or another, according to whether the surgeon thought he wanted rapid or slow absorption, led to the adoption of a number of postures in pathologic conditions. Happily, all these now remain only as examples of the fallacy of basing our practices on logic instead of clinical observations. As a matter of fact, the peritoneum is of the same structure in all its parts; and absorption, other things being equal, goes on throughout it with equal rapidity.

Surgical Pathology of the Peritoneum by Arthur E. Hertzler, M.D.

# CHRONIC PAINFUL CONDITIONS AMENABLE TO RELIEF BY INTRASPINAL (SUBARACHNOID) INJECTION OF ALCOHOL\*

ELIAS LINCOLN STERN, M.D.

Surgeon, Department Sympathetic Neural Surgery, Sydenham Hospital

NEW YORK CITY

SINCE 1931, there has been an increasing interest in the use of alcohol intraspinally.<sup>1-23</sup>

Where pathological lesions causing severe pain cannot be corrected by proper surgical or medical means, the profession has had to resort to the liberal use of narcotics, or to open operative procedures on the peripheral, sympathetic or central nervous systems. With the development of a method of controlling severe intractable pain by segmental analgesia of a more or less permanent nature, chordotomy, posterior rhizotomy, peripheral nerve sectioning and sympathectomies may become unnecessary in most cases.

Pain caused by any peripheral irritation of somatic or sympathetic nerves may be relieved by the intraspinal injection of alcohol. Pain caused by nerve root irritation may also be relieved by this method.

The following list of causes of chronic painful conditions gives one some idea of the scope and possibilities of segmental permanent analgesia. While the method is a relatively simple, safe, painless and non-shocking procedure, it may cause unpleasant complications if used improperly, or by one not thoroughly acquainted with the details of neuroanatomy and all the principles of the technique. As with other new techniques, reports will inevitably appear on the complications following the use of alcohol intraspinally.<sup>22,23</sup> These complications should be unnecessary, and are bound to follow slight deviations in technique or changes in dosages from those recommended. I have repeatedly stressed

the possible complications. This subject is fully covered in my most recent article.<sup>24</sup>

*In compiling this list, it is assumed that the usual medical and surgical treatments have been of no avail, or that operations for surgical conditions are contraindicated.* Many of the so-called "hopelessly incurable cases" having severe intractable pain may now get relief by this method.

## CAUSES OF CHRONIC INTRACTABLE PAIN

- I. In the Shoulder
  1. Aneurysm
  2. Angina
  3. Aortic regurgitation
  4. Chronic Arthritis
  5. Cancer of the liver
  6. Chronic diaphragmatic pleurisy
  7. Chronic duodenal ulcer
  8. Carcinoma of duodenum
  9. Carcinoma of gall bladder
  10. Chronic gastric ulcer
  11. Carcinoma of stomach
  12. Herpes zoster
  13. Chronic phthisis
  14. Chronic pleurisy
  15. Chronic subacromial bursitis
- II. In the Arm
  1. Adiposis dolorosa
  2. Aneurysm
  3. Brachial neuralgia, neuritis, plexus lesion
  4. Atheroma
  5. Cardiac causes
  6. Cervical caries
  7. Cervical rib
  8. Cystic diseases of breast

\* From the Department of Anatomy, Columbia University, and the Pain Relief Clinic, Sydenham Hospital, N. Y. C.

9. Growth in vertebra
10. Herpes zoster
11. Intravertebral tumor
12. Left arm—angina pectoris, aortic regurgitation
13. Right arm—angina pectoris, carcinoma of liver, heart diseases
14. Mediastinal growth
15. Occupational neurosis
16. Psychalgia
17. Radicular or root lesions
18. Syphilis of aorta
- III. In the Upper Extremity
  - (a) Brachial Neuralgia
    1. Rheumatic or gouty diathesis
    2. Malaria
    3. Chronic alcoholism
    4. Diabetes
    5. Cervical rib
  - (b) Brachial Neuritis
    1. Alcoholism
    2. Lead, arsenic
    3. Cervical rib or fibrous cord
    4. Tumor in posterior triangle of neck
    5. Glands in axilla
    6. Aneurysm subclavian artery
    7. Malignancy cervical vertebrae
    8. Caries of cervical vertebrae
    9. Spinal cord tumor
    10. Spinal gliosis
    11. Neuromata or fibroneuromata
    12. Adiposis dolorosa
  - (c) Radicular Pain
    1. Intravertebral tumor
    2. Pachymeningitis
    3. Cervical caries
    4. Malignant disease of cervical vertebrae
    5. Herpes zoster
    6. Inflammatory or vascular disease in region of posterior root ganglia
- IV. In the Breast
  1. Cancer
  2. Cystic disease
3. Epithelioma of nipple
4. Heart disease
5. Mastodynia with painful menstruation
6. Pleurisy
- V. In the Chest
  1. Adiposis dolorosa
  2. Aneurysm
  3. Aortitis, or mesaortitis
  4. Angina pectoris
  5. Bronchiectasis
  6. Chronic bronchitis
  7. Cardiac—initial pain over Cervical 2
    - Auricle—Thoracic 5-8
    - Ventricle—Thoracic 2-5
    - Ascending aorta—Cervical 3, 4
    - Descending aorta—Thoracic 1-3
    - Chronic pericarditis
  8. Tumor of ribs
  9. Disease of spine
  10. Emphysema
  11. Fracture of spine
  12. Gastric ulcer
  13. Heart burn—from regurgitation into esophagus of gastric contents—Thoracic 5
  14. Herpes zoster
  15. Intercostal myositis
  16. Intercostal neuralgia
  17. Mediastinal growth
  18. Myalgia
  19. Esophageal obstruction
  20. Pleural adhesions; pleurodynia
  21. Pulmonary tuberculosis
  22. Slipping rib
  23. Spasm of esophagus
  24. Spinal caries
  25. Spinal cord lesions
  26. Spondylitis deformans
  27. Tabes dorsalis
- VI. In the Abdomen
  1. Actinomyces of spine
  2. Chronic pancreatitis
  3. Chronic peritonitis
  4. Postoperative adhesions
  5. Chronic pleurisy associated with tuberculosis or neoplasm
  6. Aneurysm
  7. Angina abdominalis

8. Atheroma
9. Lead colic
10. Duodenal ulcer
11. Chronic dysentery
12. Epithelioma of esophagus
13. Old fracture of spine
14. Gastric ulcer
15. Gastric crises
16. Gumma of spine
17. Hypertonus of colon
18. Chronic infective osteoarthritis of spine, spondylitis deformans
19. Mediastinal growth
20. Morphia
21. Myocardial degeneration
22. Neoplasm of spine
23. Caries of spine
24. Perisplenitis, Pick's Disease
25. Chronic salpingitis
26. Spastic constipation
27. Chronic tuberculosis of colon
28. Chronic tuberculosis of glands
29. Chronic tuberculous peritonitis
30. Ulcerative colitis
- vii. In the Epigastrium, in addition to conditions enumerated in vi
  1. Carcinoma of liver
  2. Hyperchlorhydria
  3. Intercostal neuralgia
  4. Mitral disease
  5. Neoplasm of pancreas
  6. Pancreatic calculi
  7. Chronic passive congestion of liver
  8. Perigastric adhesions
  9. Chronic pleurisy
  10. Plumbism
- viii. In the Hypogastrium
  1. Severe cystitis
  2. Duodenal ulcer
  3. Gastric ulcer
  4. Liver lesions
- ix. In the Hypochondrium
  1. Carcinoma of gall bladder
  2. Carcinoma of colon
  3. Gastric carcinoma
  4. Herpes zoster
  5. Intercostal neuralgia
  6. Perisplenitis
  7. Chronic pleurisy
- x. In the Iliac Fossa
  1. Aneurysm of iliac artery
  2. Carcinoma of cecum
  3. Herpes zoster
  4. Chronic pleurisy
  5. Spinal lesions
  6. Tuberculosis of cecum
  7. Tuberculous kidney
  8. Tumor of iliac bone
- xi. In the Back
  1. Abdominal aneurysm
  2. Aortic regurgitation
  3. Carcinoma of bladder
  4. Carcinoma of spine
  5. Catamenia
  6. Duodenal ulcer
  7. Chronic dyspepsia
  8. Chronic endometritis
  9. Carcinoma of gall bladder
  10. Gastric ulcer
  11. Neoplasm of meninges
  12. Herpes zoster
  13. Impacted pelvic tumor
  14. Traumatic injuries to back; especially important in compensation cases
  15. Railway spine
  16. Lateral curvature
  17. Lumbago
  18. Malaria
  19. Osteoarthritis of spine
  20. Carcinoma of ovaries
  21. Chronic parametritis
  22. Carcinoma of rectum
  23. "Rheumatism"
  24. Rheumatoid arthritis of spine
  25. Spinal caries
  26. Tumor of spinal cord
  27. Carcinoma of uterus
  28. Carcinoma of seminal vesicles
- xii. In Kidney Region
  1. Carcinoma of kidney
  2. Pyelonephritis
- xiii. In the Penis
  1. Carcinoma of bladder (base); pain of carcinoma of ureteral orifice is referred to kidney region
  2. Carcinoma of rectum
  3. Cystitis
  4. Gout

5. Herpes zoster
6. Papilloma of bladder
7. Piles
8. Prostatic abscess, hypertrophy, calculus
9. Rectal fissure
10. Trigonal lesions
11. Tuberculosis of kidney, ureter, bladder
12. Diseases of seminal vesicles
- xiv. On Micturition
  1. Carcinoma of urethra
  2. Carcinoma of bladder
  3. Carcinoma invading bladder
  4. Cystitis
  5. Carcinoma of prostate gland
  6. Chronic prostatitis
  7. Ulceration of bladder
- xv. In the Testicle
  1. Neoplasm
  2. Tuberculosis
  3. Epididymo-orchitis
- xvi. Spasmodic Pelvic Pain
  1. Lesions of uterus
- xvii. In Ovarian Region
  1. Carcinoma of ovaries
  2. Carcinoma of uterus
  3. Carcinoma of tubes
  4. Carcinoma of kidney, ureter
  5. Carcinoma of gall bladder
  6. Carcinoma involving intestines
  7. "Hysteria"
- xviii. Bearing Down Pains
  1. Carcinoma of rectum
  2. Endometritis
  3. Fibroid uterus
  4. Hemorrhoids
  5. Ovarian tumor
  6. Retroversion of uterus
- xix. Referred Pain to Lower Extremity from Visceral Disease
  1. Disease of rectum
  2. Disease of bladder
  3. Disease of prostate gland
  4. Disease of uterus
- xx. In the Lower Extremity
  - (a) Pains of a Neuritic or Neuralgic Origin
    1. Sciatica—in pelvic inflammation, tumor, retroverted uterus, disease of hip joint, tuberculosis, syphilis, lumbosacral malignancy
  2. Anterior crural neuralgia or anterior cruritis
  3. Obturator neuralgia
  4. Meralgia paraesthetica (external cutaneous nerve of thigh)
  5. Metatarsal neuralgia
  6. Calcaneodynia
  7. Multiple neuritis
  8. Tabes dorsalis
  9. Acroparaesthesia
- xxi. With Disturbances of Circulation of Lower Extremity
  1. Intermittent claudication
  2. Raynaud's Disease
  3. Erythromelalgia
  4. Thrombo-angiitis obliterans, Buerger's Disease
- xxii. General Pains in the Limbs.
  1. Meige's Disease (angioneurotic edema)
  2. Weil's Disease
  3. Tropical congestion
  4. Leprosy-painful stage
- xxiii. Other Conditions Causing Chronic Pain Which May Be Relieved by Intraspinal Alcohol Injections
  1. Acroparaesthesia
  2. Pruritis ani
  3. Pruritis vulvae
  4. Chronic leg ulcerations
  5. Scleroderma
  6. Sympathetonia
  7. For postoperative pain—injection to be given preoperatively as before prostatic removal, amputation, extensive plastic operation, etc.
  8. Painful stumps—causalgia.
  9. Chronic spastic contractions and tremors, dystonia musculorum deformans, Little's Disease, etc.

## SUMMARY

1. The intraspinal (subarachnoid) injection of alcohol for the relief of intractable

pains has been reported to be of value by an increasing number of observers.

2. To emphasize the value and scope of this method of relieving pain, a list of chronic painful conditions amenable to this treatment has been compiled.

3. Complications following the use of alcohol intraspinally can only be avoided by strict adherence to the proper technique. Any occasional and scattered reports of untoward effects should not detract from this invaluable method of relieving pain.

#### REFERENCES

1. DOGLIOTTI, A. M. Traitement des syndromes douloureux de la périphérie par la alcoolisation subarachnoidienne des racines postérieures a leur émergence de la moelle épinière. *Presse Med.*, 67: 1249 (Aug. 22) 1931.
2. STERN, ELIAS LINCOLN. Intraspinal injection of alcohol for herpes zoster. *Med. Jour. and Rec.*, 138: 12, 479-12, 480 (Dec. 20) 1933.
3. SALTZSTEIN, H. C. Intraspinal (subarachnoid) injection of absolute alcohol for the control of pain in far-advanced malignant growths. *J. A. M. A.* (July 28) 1934.
4. STERN, ELIAS LINCOLN. Relief of intractable pain by the intraspinal (subarachnoid) injection of alcohol. *Am. Jour. Surg.*, 25: 2, 217-2, 227 (Aug.) 1934.
5. DOGLIOTTI, A. M. Recent methods of analgesia and anesthesia. *Med. Rec.*, 140: 347 (Oct. 3) 1934.
6. STERN, ELIAS LINCOLN. The intraspinal (subarachnoid) injection of alcohol for thromboangiitis obliterans. *Med. Rec.*, 141: 5 (Mar. 6) 1935.
7. DOGLIOTTI, A. M. Antalgic therapeutic methods accessible to anesthetists. *Anest. & Analg.*, 14: 150 (July-Aug.) 1935.
8. GREENHILL, J. P. and SCHMITZ, H. E. Intraspinal (subarachnoid) injection of alcohol for pain associated with malignant condition of the female genitalia. *J. A. M. A.*, 105: 6, 40609, (Aug. 10) 1935.
9. ABRAHAM, V. R. Injection of alcohol in the spinal canal for relief of pain. *Am. Jour. Surg.*, 29: 317 (Aug.) 1935.
10. FANTUS, BERNARD. Therapeutic measures of the Cook County Hospital, *J. A. M. A.* (Sept. 14) 1935.
11. STERN, ELIAS LINCOLN. Progress in spinal anesthesia; relief of pain by subarachnoid alcohol injections: experimental studies. *Clin. Med. & Surg.*, 43: 1, 7-12, Jan., 1936.
12. Year Book of Surgery, 1935; Chicago, Year Book Publishers. Relief of Intractable Pain; E. L. Stern, p. 76.
13. Year Book of Therapeutics, 1935; Chicago, Year Book Publishers. Treatment of Thromboangiitis Obliterans by the Intraspinal (subarachnoid) Injection of Alcohol; E. L. Stern, pp. 267-269.
14. GREENHILL, J. P. Relief of pain arising in female pelvis. *Med. Clin. N. A.*, 19: 4 (Jan.) 1936.
15. GREENHILL, J. P. and SCHMITZ, H. G. Intraspinal alcohol injections and sympathectomy for pain associated with carcinoma of cervix. *Am. Jour. Obst. and Gynec.*, 31: 2, 290-300 (Feb.) 1936.
16. DUNPHY, J. E. and ALT, R. E. Relief of pain by the subarachnoid injection of alcohol. *New Eng. Jour. Med.*, 214: 10, 472 (Mar. 5) 1936.
17. GOFF, C. W. Sciatic neuralgia controlled by intraspinal (subarachnoid) injections of ethyl alcohol. *Am. Jour. Surg.*, 32: 1, 37 (April) 1936.
18. STERN, ELIAS LINCOLN. The intraspinal (subarachnoid) injection of alcohol for the relief of pain and for sympathetic nervous system disorders. *Med. Rec.*, 143: 8, 327-331 (Apr. 15) 1936.
19. STERN, ELIAS LINCOLN. The intraspinal injection of alcohol for the relief of chronic bronchial asthma. *Clinical Med. and Surg.* (Feb.) 1937.
20. DE PUY, C. A. Prolonged analgesia in malignancies. *West. Jour. Surg.*, 43: 105-112, 1935.
21. DE BEULE and SCHOTTE. *Rev. Belg. des Sci. Med.*, 6: 357, 1934.
22. SLOANE, P. Syndrome referable to the cauda equina following the intraspinal injection of alcohol for the relief from pain. *Arch. Neur. and Psych.*, 34: 1120 (Nov.) 1935.
23. TUREEN, L. L. and GITT, J. J. Cauda equina syndrome following subarachnoid injection of alcohol. *J. A. M. A.*, 106: 18 (May 2) 1936.
24. STERN, ELIAS LINCOLN. Dangers of intraspinal (subarachnoid) injection of alcohol: their avoidance and contraindications. *Am. Jour. Surg.*, 35: 1, 99-104 (Jan.) 1937.



# CASE REPORTS

## TRAUMATIC INJURY OF ABDOMEN WITH EXTENSIVE DAMAGE TO COLON AND SMALL BOWEL

D. C. DONALD, M.D., F.A.C.S.

BIRMINGHAM, ALABAMA

ON August 25, 1933, at 11:30 A.M., H. R., a white male, aged ten years, was riding on his bicycle. An automobile going in the opposite direction struck him with such force that the handle of the door punctured his left abdomen and jerked out his stomach and intestines. He was thrown several feet into the air, landing on his back on a carline parkway of grass and chert, remaining in this position about thirty minutes until the ambulance arrived. When he was placed on the stretcher a section of the bowel dragging on the ground was picked up and placed on the stretcher. When he reached the emergency room of the hospital he was in shock but conscious. Examination revealed a wide, gapping, jagged, penetrating wound of the abdomen in the mid-epigastrium, 2 cm. to the left of the median line. The wound extended outward and downward below the costal margin ending in the left lower kidney fossa, with evisceration of the contents of this section of the abdomen which included the omentum, the greater portion of the small bowel, the lower portion of the stomach, exposing the spleen and stripping the muscles from the eighth and ninth ribs in the midclavicular line. The serosal and muscular coats of the colon were stripped from the mucosal tube, leaving this bare from the middle of the transverse colon to the sigmoid, at which point it was torn entirely across its lumen. The eviscerated parts were covered with blood, sand, rock and grass. The small bowel also had a rent in the jejunum 4 inches from the ligament of Treitz, which involved three-fourths of the circumference of the bowel on its anti-mesenteric border (Fig. 1).

To combat the shock 500 c.c. of 6 per cent acacia were given intravenously. Immediately under ether anesthesia, the abdomen and all

TABLE I  
FLUID INTAKE BY CONTINUOUS INTRAVENOUS DRIP  
AND URINE OUTPUT FOR 5½ DAYS

|              | Fluid Intake, c.c.   | Urine Output, c.c. |
|--------------|----------------------|--------------------|
| Aug. 27..... | 8400                 | 4384               |
| Aug. 28..... | 7250                 | 4448               |
| Aug. 29..... | 5300                 | 2624*              |
| Aug. 30..... | 7150                 | 5248               |
| Aug. 31..... | 5750                 | 4800               |
| Sept. 1..... | 1850 (first 12 hrs.) | 2368†              |

\* Remainder of urine output could not be measured, voiding involuntary.

† Intravenous drip discontinued.

exposed viscera were cleansed thoroughly with green soap and water. The rent in the jejunum was closed. The denuded tube was excised at the midportion of the transverse colon and the transverse colon was approximated to the sigmoid with end to end anastomosis. The bed of the colon, from the mid-transverse colon to the sigmoid, which was robbed of its mucous tube was left intact and the raw edges were approximated with catgut. Since we realized the chances for leakage from the colon on account of the trauma and its new position, a colostomy was made 2 cm. proximal to the anastomosis, suspending the colon extraperitoneally over a glass rod. The exposed viscera was returned to the cavity. The lacerated, jagged, abdominal wound was closed in layers, using interrupted sutures, and drainage was provided through the lateral and posterior lumbar region. Following the operation the abdominal wound was supported with multiple adhesive strips which were applied to the skin. These extended well away from the injured parts in a criss-cross manner (Fig. 2).

The outstanding conditions which had to be combatted following the injury were peritonitis, high intestinal fistula and reconstruction of the colon and the closure of the colostomy.

rise in non-protein nitrogen and urea nitrogen. When the intestinal drainage was the most free, the urinary output often dropped to 4 or 6 ounces each twenty-four hours. On one occasion

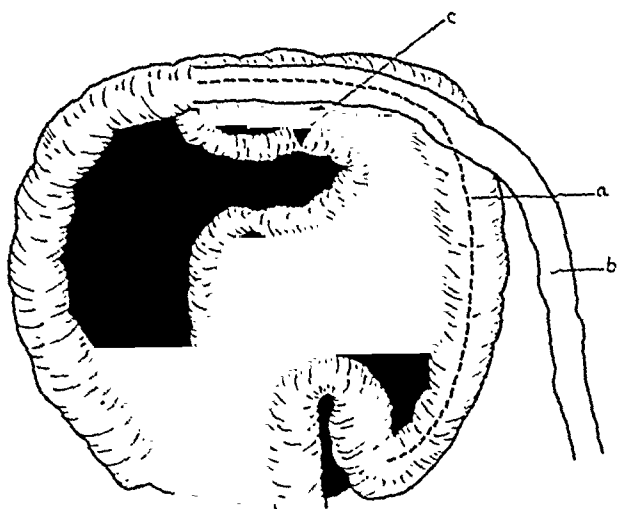


FIG. 1. Colon and small bowel injury resulting from accident; a, split in the serous and muscular coats of colon extending from the proximal transverse colon to sigmoid; b, denuded mucous barrel of colon stripped of its muscular and serous coats from the proximal transverse colon to sigmoid; c, rent in jejunum 4 inches from ligament of Treitz.

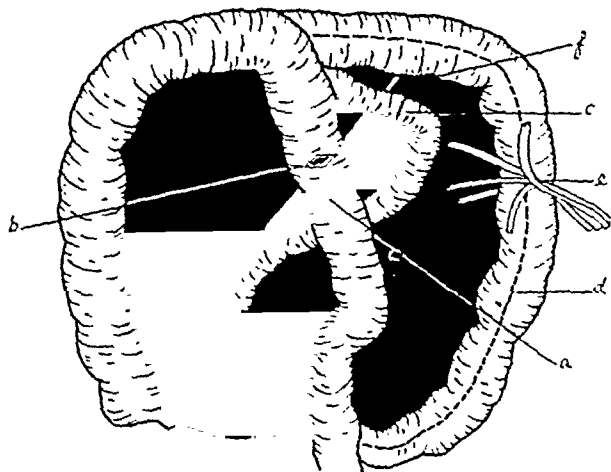


FIG. 2. Operation; a, point of anastomosis of sigmoid to the proximal transverse colon; b, colostomy 2 inches proximal to the point of anastomosis of the two colon loops; c, closed rent in jejunum; d, split through the serous and muscular coats of colon extending from proximal transverse colon to sigmoid; e, rubber tissue drains placed above and beneath the bed of the injured descending colon through the lateral and lumbar space; f, glass rod placed extraperitoneally beneath the colon at the point of anastomosis.

*Peritonitis.* During the first six days to relieve the peritoneal infection the following agents were employed: decompression of the stomach with nasal tube, multiple blood transfusions, and the giving of saline and glucose by continuous intravenous drip (Matas method<sup>1</sup>) (Table 1 and Fig. 3). On the ninth postoperative day, an intestinal fistula occurred high in the jejunum. We were not sure whether it was at the point of injury or in close proximity to the severed portion. However we did not see any linen sutures, nor did the bowel mucosa show evidence of the old injury.

Following the peritonitis, the loss of body fluids through the jejunal fistula was great and for the next thirty days in order to maintain the fluid level, 2000 c.c. or more of glucose and saline were given daily. Whenever this was omitted for twenty-four to thirty-six hours, he would develop certain characteristic symptoms, i.e., weakness, drowsiness and evidence of dehydration, and at times vomiting. The blood chemistry would show a marked

only 30 c.c. of urine was collected during twenty-four hours, and this was by catheter.

The prognosis of the intestinal fistula is based on its location. "Everything being equal, the further the fistula is from the duodenum and the first twelve inches of jejunum, the better the prognosis," is Ochsner's<sup>2</sup> theory. Colp<sup>3</sup> collected a series of 61 cases of duodenal fistula and there was a mortality of 51 per cent. In the small bowel fistulas, occurring within this region, unless some attempt is made to prevent the digestive action of the discharge, the wound will almost invariably enlarge with rapid loss of fluids, loss of electrolytes, and starvation of the patient. To combat these symptoms and signs certain things are necessary: to prevent the intestinal discharge from coming in contact with the abdominal wall, especially the skin, and to supply substances which are lost to the body through the fistulous communication.



Among the agents tried in this case were, packing the fistula with gauze and keeping it moist with beef broth and acetic acid dressings

one year following the injury, the wound had healed with a firm cicatrix, and the mucous membrane of the bowel had grown to the skin.

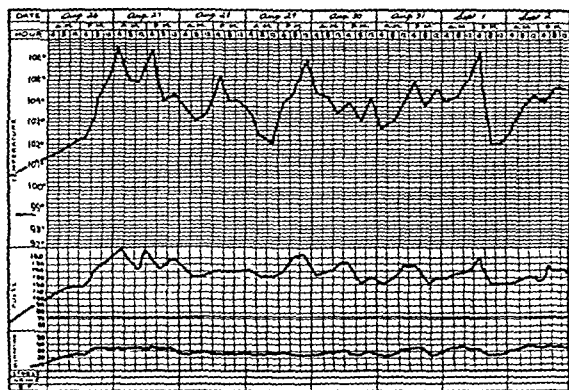


FIG. 3. Temperature, pulse and respiration rates for the first eight days.

to the skin margins. Also Fuller's earth made into a paste with olive oil was used. These measures were not applicable however in this case, because of the extensive infection of the abdominal wound which permitted a retraction of the abdominal wall and a herniation of the bowel. We found better results were obtained with a water suction apparatus, when the catheter was introduced well into the proximal loop of the fistulous bowel. The suction treatment was continued for seventeen days, and heat was also applied to the injured area in the form of a coop light. The result was the closure of the wound by granulation. The patient was confined to the hospital for two and one-half months.

When he returned home, the abdominal wound had closed with firm cicatrix, and the mucous membrane of the small bowel was firmly adherent to the skin. During the next six months the fistula was treated with beef broth applications and dressings of acetic acid. He was permitted to engage in gradual exercise. To replace the loss of body weight a high carbohydrate and protein diet was given.

He returned to the hospital on July 22, 1934, approximately eleven months following the accident, for the repair of the small bowel fistula. Surgical experience has taught us that closure in small bowel fistula in the acute stage is most apt to meet with failure due to pathological processes in the gut wall. Also within a few days the sutures will pull out and leave a larger opening than before surgery was instituted. But in this case after an elapse of

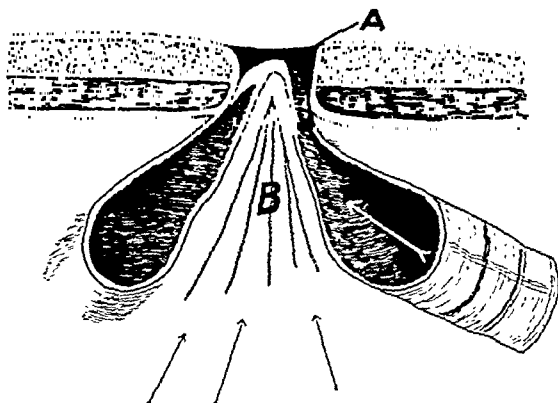


FIG. 4. A, fixation of mucous membrane of small bowel to skin; B, herniation of the mesenteric portion of small bowel.

Therefore surgery was essential (Fig. 4). On July 23, under ether anesthesia, the bowel was separated from the skin wall down to the peritoneum, and the rent in the bowel was closed in a transverse direction, using two rows of sutures, reinforced with interrupted linen sutures with rubber tissue drainage extending down to the fascia. On the fifth postoperative day the bowel began to drain with the return of the fistula. Some prosthetic appliance now seemed indicated. A T shaped tube, as recommended by Kappis,<sup>4</sup> was placed in the bowel (Fig. 5). The horizontal limb of this tube was three times larger than the vertical limb, and of sufficient weight to overcome the herniation of the mesenteric portion of the bowel. The size and weight of the tube permitted the fecal current to flow along the bowel lumen instead of to the fistulous opening. The tube remained in place for twelve days. By this time the fistulous sinus had contracted with active granulations. Therefore the tube was removed and there was an early closure of the skin wound.

*Reconstruction of the Colon and Closure of Colostomy.* No attention was given to the large bowel and to the colostomy until the small bowel fistula was closed firmly except when impaction occurred. Then mild laxatives and saline enemas were used. Meanwhile the distal barrel of the colon became incorporated in a mass of adhesion, producing a blind pouch at the point of the anastomosis. This pathological change was the result of cicatricial tissue

from the extensive infection of the abdominal wall, peritonitis, and to a less degree disuse (Fig. 6A).

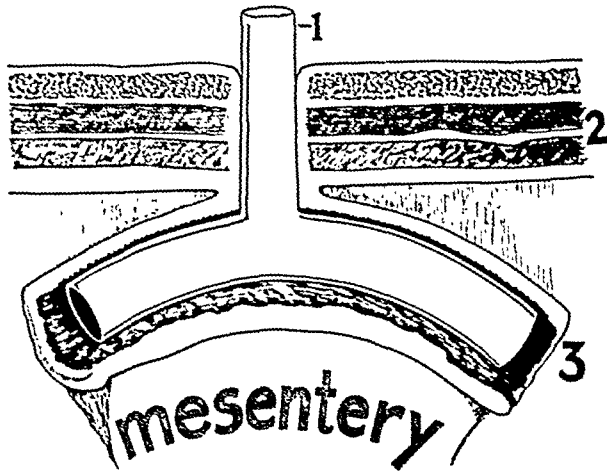


FIG. 5. 1, Vertical limb of T-shape tube extending through abdominal wall; 2, abdominal wall; 3, longitudinal limb of tube in the lumen of bowel.

Certain problems were expected to arise in connecting the two barrels, in making a patulous and well functioning large bowel. The accident had disarranged the anatomy as follows: (1) approximately 60 per cent of the mucous barrel of the colon, from the midtransverse to the sigmoid portion was sacrificed; (2) in the reconstruction of the colon the transverse end was anastomosed to the sigmoid, traversing the abdomen in a straight line from the upper portion of the cavity to the lower pelvis. The newly formed colon was suspended over many coils of the small bowel, resulting in the formation of adhesions and retraction of the cuff of serous and muscular coats of the two opposing loops.

Normally only one coil of small bowel is traversed by the colon- "duodenojejunal junction" and this is protected from colon pressure by the ligament of Treitz. It will be shown in the construction of the colon that the small bowel did interfere with the application of the clamp by the Mikulicz technique.

On January 31, 1935, under ether anesthesia, through a combined linear and elliptical incision the blind pouch of distal loop including the colostomy limb was freed of the adhesions down to the peritoneum which was entered along the left mesial surface and the two colon

barrels approximated with interrupted black silk and catgut sutures, retracting all the visible coils of the small bowel. The blind

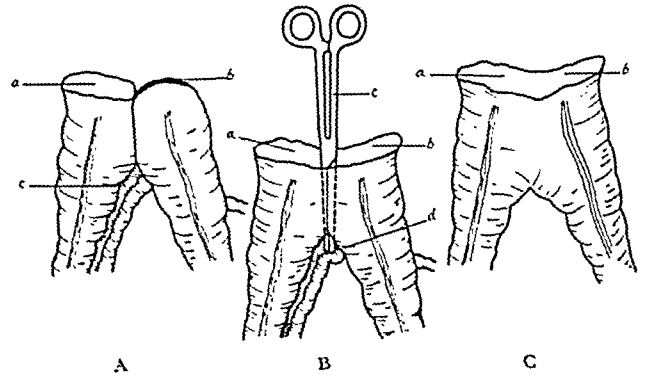


FIG. 6A. Second operation Jan. 31, 1935, the colostomy and blind pouch barrel of sigmoid were freed of adhesions down to peritoneum; blind pouch incised; both colon limbs further approximated with catgut and black silk and constricting septum of the two colon loops incised transversely and closed longitudinally; a, the colostomy barrel; b, closed sigmoid barrel; c, adhesions of small bowel to the two colon barrels.

FIG. 6B. Third operation Feb. 28, 1935; application of clamp. a, colostomy opening; b, sigmoid opening; c, clamp applied to septum of the two colon loops; d, clamp catching coil of small bowel when applied to septum producing fistula of small bowel at base of the stoma.

FIG. 6C. Fourth operation March 19, 1935; closure of colostomy; a, and b, represent the colostomy opening.

pouch was incised and the septum between the loops was excised transversely and closed longitudinally, attempting to enlarge the lumen to a size which was sufficient to take care of its need. But inflammatory lesions of colon behave as any other mucous lined viscus in that the chances for reclosure of the lumen will often interfere with its function. Thus additional excision by surgery or clamp is required.

Approximately one month later, a digital examination was made which revealed a firm spur with its greatest density along the distal barrel on the mesenteric border. The mucous barrel was pulled externally and under guidance of the finger the clamp was applied, crushing the spur 3 to 4 inches, and each day tightening it an additional notch. On the fifth day the clamp cut through and within a short time the same day there appeared a small bowel drainage at the base of the newly formed stoma (Fig. 6B). In applying the clamp to the spur the clamp extended beyond the spur and caught a portion of the small bowel, producing the fistula, additional to the colostomy. We soon

saw that the drainage of the small bowel fistula produced less skin irritation than the previous jejunal fistula and the amount of

In October, 1935, the lumen of both barrels of the colon were reexamined digitally. We found that the colostomy barrel was narrowed



FIG. 7. X-ray picture of the colon as of May 1, 1936.

drainage was not as great. In this fistula there was not the body wasting and toxemia that was found in the jejunal fistula. The conclusions were that we were dealing with a fistula lower down in the small bowel, presumably the ileum. No special treatment was given to correct this accidental injury except for occasional tamponading of the opening in the small bowel with gauze. At this time the patient returned home and was kept under observation until July.

On July 10, 1935, under ether anesthesia, through an upper right rectus incision, extending from ensiform to below the umbilicus, the abdomen was explored. Several coils of the small bowel adherent to the two colon barrels were freed, and the loop of the small bowel (ileum) that furnished the fistula was detached from the colon spur. The rent in the bowel was closed in a transverse direction. The colon barrels were further approximated with black silk and catgut to a point close to the retro-peritoneal wall, thus permitting only one coil of the small bowel (jejunum) to escape. The abdomen was closed without drainage.



FIG. 8. Patient, as of August 8, 1936, a normal boy.

by a constricting spur which was sufficient to interfere with the closure of the colostomy. The mucous barrel was now brought forward toward the colostomy opening and the clamp was applied to the spur for 4 inches. On the following fourth day the clamp cut through, thus giving the lumen of the colon sufficient space to take care of its need (Fig. 6c).

In March, 1936, the colon was rechecked for additional spurs and it was found free. Then under ether anesthesia the colostomy was freed from the skin down to the peritoneum and closed in a transverse direction. The abdominal wall was closed with interrupted catgut and silk sutures with a wick drain. The wound was reinforced with adhesive strips which were placed in a criss-cross manner. After four to six weeks the patient was permitted to take supervised exercise. At the present time he is

having one or more normal bowel movements each day (Figs. 7 and 8).

#### CONCLUSIONS

1. The mortality from penetrating wounds of the abdomen with visceral injury is in proportion to the time that elapses after an accident and the time that surgery is instituted. The mortality is 40 to 50 per cent in cases where the injured person is given immediate surgical treatment, whereas the cases which are permitted to reach the peritonitis stage before any attempt is made for surgical repair are all fatal.

2. Permanent colostomy at the transverse colon and the closure of the sigmoid loop would have reduced the time of the operative procedure, and very likely this treatment would have had the sanction of many experienced surgeons in treatment of similar colon injuries.

3. If the sigmoid had been permitted to remain loose in the pelvis and an attempt had been made later to connect it with the colon when the patient's condition permitted, the results for obtaining a patulous colon would have been problematical due to the pathological changes, such as lack

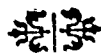
of development of sigmoid with the growth of the child and the subsequent adhesions which follow injury.

4. Although after our operation the sigmoid loop developed into a blind pouch and remained so for approximately two years, the anastomosis kept the two colon barrels in apposition and made it accessible for some form of reconstruction operation.

5. The value of continuous intravenous drip cannot be over estimated in a case of acute toxemia which is associated with infection, whether the infection originates in the peritoneal tissue or elsewhere. The daily average of intravenous glucose and saline in the present case for the first five days ranged from four to eight liters per day.

#### REFERENCES

1. MATAS, RUDOLPH. The continued intravenous "drip" with remarks on the value of continued gastric drainage and irrigation by nasal intubation with a gastroduodenal tube, Jutte, in surgical practice. *Ann. Surg.*, 79: 643-661 (May) 1924.
2. OCHSNER, ALTON. *Surgery of The Intestines*. Nelson Loose Leaf Surgery, vol. 5.
3. COLP, R. External duodenal fistulae. *Ann. Surg.*, 78: 725, 1923.
4. KAPPIS Cited by Kaehler, M. Treatment of high Intestinal fistulae. *Zentrabl. f. Chir.*, 52: 2418, 1925.



# STAB WOUND OF HEART, RIGHT VENTRICLE\*

WALTER D. LUDLUM, JR., M.D., F.A.C.S. AND ABRAHAM KATZ, M.D.

NEW YORK CITY

CARDIORRHAPHY is no longer an interesting curiosity but a formidable challenge to the surgeon's ability to save lives. Statistical study of cardiac wounds shows a definite decrease in mortality with wider interest in surgical intervention. Peck in 1910, reported 160 cases with a mortality of 63 per cent. In 1912, Pool added 77 more cases to the literature, the mortality this time having been reduced to 45 per cent. Smith and Schoenfeld reported 74 cases, the mortality of which was 31 per cent. In these statistics inaccuracies are inevitable because many cases of attempted suture doubtless terminated fatally and were not reported.

The great French surgeon, Ambroise Paré, (1510-1590) was among the first to remark on the possibility of survival in a patient with a wounded heart. Early in the seventeenth century, Weber had dissected an elk and found a healed scar at the apex of the left ventricle. But a strong prejudice persisted that all heart wounds were fatal. As late as the close of the nineteenth century, so eminent a surgeon as Billroth remarked, "Let no man who hopes to retain the respect of his medical brethren dare to operate on the human heart." In the history of heart wounds, we find the name of Morgagni (1776) preeminent because it was he who first described heart tamponade as one of the causes of death in heart wounds. In 1793, Maron Larrey with a needle removed fluid from the pericardium. Fisher, in 1868, collected 452 cases of heart wounds of which approximately 10 per cent survived without operative interference. In 1882, Block sutured the heart of a rabbit. In 1894, Del Vecchio demonstrated healed cardiac wounds of a dog that had been treated surgically. The first case of suturing of a human heart was

reported by Cappelen of Christiana in 1895. His patient died five days later but the wound was in good shape. Rehn was the first surgeon to suture the heart of a man who completely recovered.

Stab wounds of the heart which reach operation are still sufficiently rare to merit report of an additional case. Our survey of the literature until 1932 revealed 365 operated cases. The location of the heart wound was distributed as follows: left ventricle 167; right ventricle 125; left auricle 19; right auricle 21; miscellaneous 33. This does not include the 58 wartime cases reported by Sir Charles Ballance in his Bradshaw lecture, which makes our grand total 423 cases. Dshnelidze in a Russian article reported 535 operated cases but unfortunately his sources are inaccessible.

Although haste is imperative once the diagnosis of heart wound has been made, certain important elements in the preparation should not be omitted. In cases which appear to have had a successful suture, the most common cause of death is infection. According to Peck, infection is present in over 5 per cent of recoveries and in 50 per cent of fatal cases. Consequently, a careful scrubbing and iodination of the skin and the use of instruments that have been properly sterilized, are necessary. Anesthesia apparatus providing differential pressure is a valuable adjunct in case pneumothorax develops. Preoperative treatment is ordinarily minimal on account of the urgency of operation. It appears, however, that cardiac embarrassment is lessened in many cases by placing the patient in a sitting rather than recumbent position. Blood typing with facilities for transfusion and infusion may prove life-saving precautions.

\* From the Surgical Service, Gouverneur Hospital, New York City.

Many cases are comatose and no anesthesia is required until cardiac embarrassment is relieved. Then light, open cone ether will carry the patient safely. The rib-flap operation has been the operation of choice. An over and over suture or a mattress suture of the heart may tear through, particularly in the thin right ventricle or in the auricles, whereas purse string suture may succeed, or suturing the pericardium to the heart wall may close the defect. Minimal handling of the heart may make the difference between successful and fatal outcome. Handling about the base of the auricles is particularly dangerous on account of the presence of vital nerve centers. Drainage at the lower end of the sutured pericardial wound is desirable but no drains should enter the pericardial sac.

#### CASE REPORT

*History.* J. S., a white man, age about forty years, was picked up from the street by the ambulance. He was unconscious, his breathing labored, his face cyanotic with its veins and the veins of the neck and arms dilated. The pupils were dilated, pulse was imperceptible but the extremities were warm. A  $\frac{5}{8}$  inch almost horizontal stab wound was found in the left anterior chest, in the fifth interspace just to the left of the sternum. There was moderate oozing from this wound. A second wound about one inch long with omentum protruding from it was located in the left upper quadrant of the abdomen. The heart margins were not readily defined. The heart sounds were inaudible, as there were numerous rales throughout the chest. The blood pressure was zero.

A diagnosis was made of stab wound of the heart with heart tamponade, complicated by stab wound of the abdomen. Immediate operation was decided and infusion was started preoperatively.

*Findings.* On reflecting the skin and pectoral muscles, a  $\frac{1}{4}$  inch triangular metallic fragment, like a metallic scale was found in the depths of the wound. The stab wound had penetrated at the angle between the costal cartilages and the sternum in the fifth interspace. On entering the thorax, a left pneumo-

thorax developed, and the lung overlying the heart retracted. The tense pericardium with blood clot shining through it was incised and the clot evacuated. The left auricle and ventricle were intact. Rotation of the heart revealed oozing from the right heart. The heart was beating weakly and irregularly. A clot adherent to the right ventricle was removed. Blood spurted through a half inch wound which, at the time, was believed to be leading into the right auricle.

*Operative Procedure.* Without any anesthesia, a semicircular incision with concavity upward and to the left, was made. The incision was placed to the left of the sternum and overlying the third to the seventh costal cartilages. The skin and pectoralis muscles were quickly elevated and the third to the seventh costal cartilages severed near the sternum. The fourth, fifth and sixth ribs were fractured at the nipple line and the osteomuscular flap hinged laterally. The pleural cavity was inadvertently entered. The left lung immediately retracted. The pericardium was slit longitudinally and the clot evacuated. The heart was elevated with the left hand, the adjacent left side of sternum was resected and the remaining right side retracted. The heart was rotated and the clot removed from over the right ventricle. The half inch wound of the right ventricle was sutured with continuous suture of No. 1 plain catgut. When the last suture had been inserted the heart ceased beating. The patient had been getting saline intravenously. Adrenalin had been administered three times, the last time into the heart itself. Artificial respiration and cardiac massage were all without avail.

*Autopsy Report.* There is a sutured stab wound on the anterior wall of the right ventricle below the conus,  $1\frac{1}{2}$  inches below the right auricular appendage, and 2 inches to the left of the interventricular sulcus. This wound is held together by a continuous suture which when removed, exposed a cut wound of the heart, measuring  $\frac{1}{2}$  inch in length; the edges are approximated. Three-quarters of an inch beneath this wound, there is a smaller wound, also a penetrating stab wound of the heart,  $\frac{3}{8}$  inch in length, the edges of which are cut clean. This wound also leads into the cavity of the right ventricle. It is possible to pass a probe through the superior wound in the ventricle and out to the inferior wound which may represent the continuation of the tract.

## COMMENT

This case of stab wound of the heart is rather exceptional, in that it was complicated by two right ventricle wounds, only one of which spurted blood at operation. It was further complicated by a stab wound of the abdomen with protrusion of the omentum.

## REFERENCES

- BALLANCE, C. A. The Bradshaw Lecture on the Surgery of the Heart. London, Macmillan and Co., 1920.  
 BENET, G. and SPIVEY, C. G. Suture of stab wound of the heart. *J. A. M. A.*, 104: 1979-1981 (June 1) 1935.

- BIGGER, I. A. Wounds of the heart and pericardium. *South. Med. Jour.*, 25: 785-794 (Aug.) 1932.  
 PECK, C. H. The operative treatment of heart wounds. *Ann. Surg.*, 50: 101, 1909.  
 POOL, EUGENE H. Treatment of heart wounds. *Ann. Surg.*, 55: 485, 1912.  
 RHODES, ROBERT I. Suture of stab wound of the heart. *Ann. Surg.*, 81: 757, 1925.  
 SCHOENFELD, HERBERT H. Heart injuries with suture. *Ann. Surg.*, 87: 823, 1928.  
 SINGLETON, ALBERT G. Wounds of the heart. *Am. Jour. Surg.*, 20: 515-541 (June) 1930.  
 SMITH, WM. RANDOLPH. Cardiorrhaphy in acute injuries. *Ann. Surg.*, 78: 696, 1923.  
 STEWART, FRANCIS T. Five cases of suture of heart. *Ann. Surg.*, 58: 67, 1913.  
 VANTRIN et GUILLEMIN. Wounds of left auricle. *Rev. de chir.*, 62: 294, 1924.



## CARE of Rubber Gloves:

1. All gloves should be washed in cold water before being removed. (This should be insisted upon in every operating room.)
2. After removal all gloves are again washed inside and out with cold water and soap by the nurse.
3. All gloves are wrapped in a piece of muslin and boiled for five minutes. (Muslin is used to keep the glove from sticking to the sides of the sterilizer.)
4. After boiling, the gloves are lifted out of the sterilizer and the water drained off. They are removed from the muslin package and hung on a glove tree to dry, placing a prong of the tree into one finger of each glove. If there is no tree, the gloves may be hung over cloth covered rods stretched across a drying closet (small steam heated room).
5. When gloves are dry on the outside, they are turned and allowed to dry on the inside.
6. When dry, they are sent to the work room to be repaired, powdered and put up in labeled packages.

Operating Room Procedure by Henry C. Falk, M.D.

# MUCOCELE OF APPENDIX WITH PSEUDOMUCINOUS DEGENERATION\*

C. HIRAM WEAVER, M.D., F.A.C.S.

Attending Surgeon Hollywood Hospital; Surgical Staff, Cedars of Lebanon Hospital; Chairman, Malignancy Committee, Hollywood Hospital

LOS ANGELES, CALIFORNIA

MUCOCELE of the appendix was first recognized as a pathological entity of Rokitansky in 1842.<sup>1</sup> It was again mentioned by Virchow in 1863,<sup>1</sup> and Werth is credited with giving the term "Pseudomyxoma peritonaei" in 1884, because of the gelatinous masses which he found throughout the peritoneal cavity, and which was proved to be pseudomucin instead of mucin. Fraenkel in 1901 reported a mucocoele of the appendix in the male, which ruptured and he retained the term "pseudomyxoma peritonaei" because of the gross similarity of the gelatinous exudate to that found in cases previously reported under the same name in women. A little later Olshausen wrote that he believed the epithelial cells from the lining of the ruptured cyst were transplanted to the peritoneum, and that there they took root and continued to secrete the gelatinous material. As to frequency, Castle<sup>2</sup> reported a 0.2 per cent of mucocoele of the appendix in 13,158 necropsies. Dodge, in 1916, reviewed the literature and found only 142 cases reported. Norment<sup>3</sup> studied 45,000 appendices removed surgically at the Mayo Clinic and found 36 mucocoele cysts. Weaver,<sup>4</sup> in 1928, was able to find 168 reported cases of mucocoele of the appendix. In April, 1932, Mayo and Fauster<sup>5</sup> studied 31,200 appendectomies performed in the Mayo Clinic from 1917 to 1930, with a total of 76 pathologically proved cases of appendiceal mucocoele. This last series did not include 6 cases of pseudomyxoma peritonaei originating from mucocoele of the appendix reported by Masson and Hamrick,<sup>6</sup> of the Mayo Clinic, in 1929. I am now able to report on 6225 appen-

dectomies studied pathologically at the Hollywood Hospital in the ten years from 1925 to 1934, inclusive. In this series of appendectomies 7 mucocoeles of the appendix were found, one of which, the case reported, had gone on to pseudomyxoma peritonaei. The percentage of this series is 0.11. Totalling the available reported cases there were 256 instances of mucocoele of the appendix, either with, or without the existence of pseudomucinous peritonaei.

Two aspects of the disease present themselves in the clinical picture; the first is circumscribed and is caused by the fact that the mucinous fluid remains confined within the walls of the appendix, thereby forming a cyst; the second step, or stage, of this disease is a diffuse myxomatous invasion throughout the whole peritoneal cavity, producing myxomatous degeneration. If spontaneous perforation of the appendiceal mucocoele occurs the gelatinous fluid will seep through the small opening, and, by means of peristalsis of the intestine, be deposited in any part of the abdomen.<sup>7</sup>

There are many explanations quoted concerning the continuation of mucinous, or pseudomucinous fluid found outside of the original cyst, or cysts. It seems most probable that the appendiceal mucus cells are carried away into the peritoneal cavity, attaching themselves to the peritoneum, thus continuing to function and produce the mucinous fluid. This explanation seems very probable with the pathological report in mind of the case to be reported.

Pertaining to the percentage of occurrence of mucocoele of the appendix it seems probable that 0.2 per cent of all cases of

\* Read before the Los Angeles Surgical Society, October 18, 1935.



appendiceal pathology is nearly correct. It happens occasionally that as a result of an attack of acute appendicitis, which has stopped short of perforation, or, has subsided spontaneously, that a stricture is formed in the proximal part of the appendix at, or near, its junction with the cecum.<sup>8</sup> If the original infection dies, or remains of so low an intensity as to stimulate the mucus secreting cells without leading to further attacks of acute appendicitis, the appendix may become distended with mucus, and, as the pressure within the now closed viscus rises, hernial protrusions of the mucous membrane projects through the muscular coat and form diverticula, which are recognizable as spherical swellings beneath the peritoneum. Such distention of the appendix may increase slowly until the organ becomes many times its normal size, or, at any point its progress may be cut short by a rupture of one of the diverticula. If this occurs the mucus is discharged into the peritoneal cavity, the appendix collapses, the rupture of the diverticulum heals, and the process commences again. This sequence may be repeated at periodic intervals for many years before it causes symptoms or physical signs sufficient to achieve clinical recognition. Exuded mucus is not absorbed by the peritoneum, but becomes encapsulated in the form of droplets or larger masses, either by the omentum or by the growth of filmy connective tissue produced by a local plastic peritonitis, as was found in the case to be reported. In the course of time the abdomen becomes distended by gelatinous masses (pseudomyxoma peritonei) as in the more common, allied condition caused by rupture of a mucus secreting ovarian cyst.

Present day knowledge is not sufficient to answer the question as to whether the pseudomucinous fluid in the abdominal cavity is inflammatory or neoplastic. That it may be inflammatory is supported by the fact that a pseudomucinous condition has been reported in some cases to have

spontaneously regressed, while in others it took a neoplastic course.

Therapy consists in removal of the diseased appendix and as much as possible of the mucinous material. Bearing in mind that a malignant degeneration<sup>6</sup> may take place, postoperative irradiation is justified. In reviewing the literature no definite x-radiation therapy is advised by the authors as to dosage, filtration, etc.

#### CASE REPORT

Mrs. A. H. S., aged seventy years, female, white, a motion picture actress, complained of enlargement of the abdomen, constipation and some loss of weight.

*Family History.* Father died, aged sixty-six years, of tuberculous peritonitis; her mother died, aged ninety-four years of senility. The remainder of the history was irrelevant.

*Past History.* Measles, mumps, pertussis as a child, pneumonia at the age of 12 years. In 1901, at the age of thirty-six years, she had an attack of appendicitis and was bedridden for three months but was not operated. In 1904, she had typhoid fever with uneventful convalescence. Patient was born in the South.

*Menstrual History.* Menses began at fourteen years, with uneventful menopause at the age of fifty years. She had never been pregnant.

*Present History.* About three years ago patient noticed a gradual enlargement of the abdomen, which caused her no distress; however, recently her chief complaints are slight loss of weight, enlarged abdomen, poor appetite, easily exhausted and obstinate constipation.

*Physical Examination.* Her temperature is 99.4°, pulse rate 96, and blood pressure 134/60; height 5'8" and weight 143 pounds. The general appearance is that of a tall, angular type woman of apparent age of seventy years, in no pain and very talkative.

Head and neck, eye, ear, nose and throat, heart and lung examinations are essentially negative for her age. When standing, the abdomen protrudes very markedly. Measurements of abdomen at the level of the umbilicus is 44 inches. When lying flat there are no masses palpable within the abdomen, no tenderness and palpation note is flat throughout.

*Vaginal Examination.* Except for a urethral caruncle there is very little to be palpated. The uterus is small and has undergone senile

atrophy. One can palpate apparent fluid anterior to the uterus and in either adnexal region. Rectal examination confirms vaginal.

*Extremities.* Arms and legs are negative, and no edema is evident.

*Essential Laboratory Findings.* The urine is negative.

*Blood.* 3,910,000 erythrocytes, 60 per cent hemoglobin, 8050 leucocytes, 62 per cent polymorphonuclears, 5 per cent large monocytes, 28 per cent lymphocytes, 3 per cent eosinophiles and 2 per cent basophiles. The coagulation time is 6 minutes 15 seconds.

X-ray studies of gastrointestinal tract, November 5, 1934, are essentially negative; the appendix was not observed at any time during the series. Roentgenogram of the gall bladder reveals no dye showing at any time in the gall bladder and therefore diagnosed as a non-functioning gall bladder. A barium enema reveals a highly spastic descending colon, otherwise negative.

*Operation,* November 23, 1934, under spinal anesthesia, making a midline incision from the pubis to 3 inches above the umbilicus. On entering the peritoneal cavity it was found that a huge cyst was attached to the peritoneum of the anterior abdominal wall. This was easily separated and one could palpate a large cystic mass completely filling the abdomen, from the pelvis to the diaphragm. In attempting to free the cyst wall as it passed posterior to the greater omentum, the cyst ruptured and was evacuated of slightly over two gallons of gelatinous, colloid material. The cyst wall was attached to the pelvis, extending up both sides of the abdomen, attaching itself to the inner lateral aspect of the ascending and descending colon, going underneath the omentum and stomach and was attached to the posterior peritoneum above the left kidney, the root of the mesentery below the liver, and to the jejunum near the ligament of Treitz. In peeling off this cyst wall, which was very fragile, many small pieces of the wall were undoubtedly left within the abdominal cavity. There were also large groups of colloid material above the stomach, and between the liver and the chest wall. These were cleaned out as well as possible with the gloved hand. Where the cyst wall was attached to the inner lateral side of the cecum it was found that the appendix penetrated the cyst wall and extended downward, parallel to the right side of the rectum,

a distance of 7 inches. The cyst wall was cut down to the root of the appendix and an appendectomy done. It was found that the appendix had undergone complete calcareous degeneration, with the end of the appendix lying open and containing a fecalith, the size and shape of an olive seed. Both ovaries had apparently undergone complete calcareous degeneration and were extremely hard to palpation. The left ovary was removed for diagnosis. The patient left the table in fair condition.

*Pathological Report.* The specimen consists of a fibrous wall showing quite a little colloid material on the surface. The wall itself is rather thick, presents many small cysts filled with colloid, giving the impression that it is a colloid carcinomatous condition. The ovary is irregular in outline, measuring 3.5 by 3 by 2.25 cm., calcified. What has been taken for the appendix is a tube measuring 5 cm. in length by 2.25 cm. diameter. Its outer surface is rough with many adhesions. Cutting through the wall it is calcified, giving the impression of arteriosclerosis. Its central part contains a partially organized clot. At the tip is a piece of tissue shaped like a date seed and measuring 2.25 by 1 by 0.7 cm. It is a little rough, translucent in appearance and fairly firm.

*Cyst Wall.* Portion of the cyst wall is fibrous and on either surface there are small colloid cysts, giving a definite impression of carcinoma. Specimen measures six quarts, weighs 13½ pounds.

Microscopic section from what was taken to be the appendix shows a typical appendiceal wall, fibromuscular structure with the lumen presenting very little round cell infiltration but hypertrophy and hyperplasia of the cylindric cells of the lining mucosa, which are actively secreting mucus. There is no invasion of the muscular structures. The calcified wall presents quite a typical bone formation with some calcified material.

Section from various parts of the cyst wall shows a fibrous structure with scattered pockets of mucoïd material with quite a little round cell infiltration. Occasionally one sees cylindric cells on the surface of these cysts actively secreting mucus. At no point, however, do they invade the wall. No mitotic figures are recognized and the cells are quite normal as to size, shape and staining properties. At no point is there any evidence of a colloid carcinoma as

would be shown by the eccentric nuclei. I am inclined to view the condition as a mucocoele of the appendix, especially the distal end which has ruptured and produced a pseudomyxomatous peritonei, which occurs sometimes in this condition. The condition is not malignant in the sense that a carcinoma has developed, but is malignant clinically in that the condition tends toward the death of the individual.

Microscopic section of the ovary shows quite typical bone formation throughout.

Mucocoele of the appendix with pseudomyxomatous peritonei.

This patient went through an uneventful convalescence and on December 22, 1934, thirty days postoperatively, was started on x-ray therapy to January 11, 1935, a series of fourteen treatments, receiving 1386 r units over the abdomen and 1192 r units over the pelvis.

#### SUMMARY

A short history on mucocoele of the appendix is presented, and a report is given of those found in a total of 6225 appendectomies studied pathologically at the Hollywood Hospital in the ten year period from 1925 to 1934, inclusive, with a percentage of 0.11. The total number of available reported cases in the literature is 256.

The interesting features of the case presented was that the first and only known attack thirty-four years previous

to operation was treated conservatively; the patient was in bed for three months and was not operated. At the time of operation about nine quarts of mucinous material was removed. The postoperative treatment is discussed, in that this case was treated as a low grade malignancy and received deep x-ray therapy following operation. Two years postoperatively, the patient shows no evidence of recurrence of the disease.

Recent check-up of this patient in December, 1936 reveals her to be apparently in good physical condition. The abdomen now measures 33 inches in circumference at the umbilicus and there is no evidence of a return of the disease.

#### REFERENCES

1. RANZI, EGON. *Über Mukokelen der Appendix.* *Wien. med. Wchnschr.*, 76: 643-45, 1926.
2. CASTLE, OTTO L. Cystic dilation of the vermiform appendix. *Ann. Surg.*, 61: 582-88, 1915.
3. NORMENT, W. Carcinoma of the appendix. *South. Med. and Surg. Jour.*, 94: 439-41, 1932.
4. WEAVER, DON D. Mucocoele of the appendix. *California and West. Med.*, 28: 500-01, 1928.
5. MAYO, CHAS., JR., and FAUSTER, JOHN N., JR. Mucocoele of appendix, with report of case. *Minnesota Med.*, 15: 254-56, 1932.
6. MASSON, J. C. and HAMRICK, ROBT. A. Pseudomyxoma peritonei originating from mucocoele of appendix. *Surg. Gynec. and Obst.*, 50: 1023-29, 1930.
7. DAVISON, MARSHALL. Mucocoele of vermiform appendix. *Internat. Clin.*, 2: 303-9, 1922.
8. MILLIKEN, G. and POINDEXTER, C. A. Mucocoele of appendix with globoid body formation. *Amer. Jour. Path.*, 1: 397-402, 1925.



# GASTROJEJUNOCOLIC FISTULA\*

## A BRIEF REVIEW OF THE LITERATURE AND REPORT OF A CASE

ADOLPH VON PRIEF FARDELMANN, M.D., F.A.C.S.

Attending Surgeon, Lutheran and Bushwick Hospitals

BROOKLYN, NEW YORK

IN 1903 Czerny reported the first case of gastrocolic fistula following gastroenterostomy. The 70 previously reported originated from cancer of the stomach or colon. In 1912 Haudeck made the first roentgen ray diagnosis of gastrocolic fistula caused by carcinoma of the stomach. Burnham in 1917 reported the first carcinoma of the colon with fistula into the stomach, in which the diagnosis was made with roentgenograms. Verbrugge in 1924 studied all previously reported cases and wrote the most complete article on the subject. He collected 202 cases from the literature and added 14 more, making a total of 216 cases. Since then up to 1930, 13 more cases were added by various authors, making a total of 229 cases reported from 1903 to 1930.

### ETIOLOGY

Verbrugge noted that fistulas due to carcinoma were decreasing and that those due to gastrojejunal ulcer were increasing with the growing popularity of gastroenterostomy for the treatment of gastric and duodenal ulcer. Trauma, abdominal tuberculosis and gastric ulcer are uncommon causes. Early diagnosis and intervention in cases of cancer of the digestive tract have lowered the number of these large tumors so that fistulas due to their extension have been reduced.

The incidence of fistulas following gastroenterostomy is variously stated. It is quite excepted that when it does occur it is usually in the period from a few weeks to nine and one-half years after operation. Its occurrence is dependable on the number of jejunal ulcers that appear postoperatively.

Most authors agree with Pratt that jejunal ulcers following gastroenterostomy practically always occur in the group of cases whose original trouble was a duodenal ulcer rather than gastric ulcer.

Lewishon, of Mt. Sinai, claims jejunal ulcer occurred in 35 per cent of the gastroenterostomy cases for duodenal ulcer done at Mt. Sinai between the years 1915 and 1920. Most all other authors consider these figures too high.

Balfour states that the occurrences of gastrojejunal ulcer in a series of 500 cases of gastroenterostomy for duodenal ulcer observed over a ten year period was 3.26 per cent; the British Medical Association survey of 744 cases observed over a period ranging from four to nine years was 2.8 per cent, and the Germans report 5 per cent. Mayo and Rankin estimate that gastrojejunal ulcer occurs in 1 to 3 per cent of patients following operation for gastric and duodenal ulcer. Lahey in 1935 wrote, "It is interesting to note that gastrojejunal ulcer is now considered a serious and not unlikely complication of any operative procedure for ulcer in which the stomach is anastomosed to the intestine and not a sequela peculiar only to gastroenterostomy."

The etiology of gastrojejunal ulcer is still in a state of hypothesis. Supposed causes are: (1) sudden exposure of the jejunum to hyperacid gastric contents; (2) the use of unabsorbable sutures and Murphy buttons; (3) operative trauma to the mucosa by use of heavy clamps, etc. and (4) focal infection. In addition, other factors that contribute to this sequela of gastroenterostomy, are: (1) carelessness in postoperative diet and medical supervision; (2) the same causes that produced

\* Read before Surgical Section of the Queens County Medical Society, June 25, 1936.

the original ulcer; (3) type of operation, (particularly frequent after von Eiselsberg pyloric exclusion operation); (4) breaking down of hematoma; (5) syphilis; (6) faulty operative technique, particularly placing the anastomosis too high (Woolsey); (7) excessive smoking, alcoholism and the use of condiments; (8) fatigue and exposure, and (9) arteriosclerosis. In other words, the cause of jejunal ulcer is really unknown. However, it is definitely known that primary ulcer of the jejunum is extremely rare.

#### AGE AND SEX

All patients at the Mayo clinic series were between twenty-seven and sixty-one years of age. In all the reported cases, all but one were males. Eusterman asserts that the proportion of males to females affected with gastric and duodenal ulcers is 3:1, and that with jejunal ulcers is 6:1.

#### PATHOLOGY

Fistulas in cases of carcinoma of the stomach or colon are part of the tumor itself. Fistulas due to perforation of a jejunal or gastrojejunal ulcer are essentially different. In brief, first a duodenal ulcer or other gastric pathology, then following a gastroenterostomy an ulcer develops at the stoma and spreads around the jejunum. The perforating ulcer, and all jejunal ulcers tend to perforate, becomes plastered to the colon and finally perforates it, forming the fistula. After perforation the ulcer, as a rule, heals and the mucosa appears normal. This process is accompanied with more or less adhesions depending on the amount of spreading local peritoneal inflammation. In many cases the efferent jejunum becomes swollen and thickened due to infection from the colon.

#### SYMPTOMS

The symptoms of gastrojejunal fistula are along the lines of evolution. There is first, the symptom syndrome of the associated lesion. In cancer of the stomach or colon, the usual findings of these dis-

eases, then at some time or other perforation occurs, with more or less abdominal pain, to be followed by the symptoms of fistula.

In the jejunal ulcer cases, the patient has been operated upon for his primary gastric or duodenal ulcer with a definite improvement in his health over a period of six months to nine and one-half years. Then he may, or may not, have the symptom complex of jejunal ulcer to be followed by the findings of fistula which are:

1. *Diarrhea.* This is the most constant of all symptoms and results in the patient's loss of general good health. Stools average six to ten a day; are usually yellow, soft, with strong foul odor, acid in reaction (due to gastric secretions or fatty acid) and contain neutral fats. Lienteric stools may occur. It does not yield to medication as a rule.

2. *Eructation* of foul gas is often present. Often medication given in an enema may be tasted.

3. *Vomiting* of fecal material is not a common occurrence, but when it occurs in the absence of intestinal obstruction, it is pathognomonic of the disease.

4. *Pain* is rare and not dependable. It may be localized above the umbilicus from the perforating ulcer, or cramps that are generalized, due to partial intestinal obstruction.

5. *Loss of weight* occurs although the patient has a normal appetite. The loss is sometimes considerable, accompanied by marked dehydration and general weakness.

#### PHYSICAL SIGNS

These vary considerably and are of little value. Abdominal palpation is usually negative. Peristalsis is active and perhaps high pitched sounds may be heard over the fistula. Occasionally in the emaciated patient, peristalsis may be seen.

#### DIAGNOSIS

Wasting without apparent cause, abdominal discomfort or pain (usually with a previous history of jejunal ulcer), fecal

smelling eructations, fecal vomiting without evidence of obstruction, or alimentary vomiting in which the presence of sterobilin and indole can be demonstrated, diarrhea, the stools containing undigested food, fats and hydrochloric acid. Colored meals rapidly appear in the stools. Colored enema solutions are quickly recovered by gastric lavage. Roentgenographic study is most important in establishing the diagnosis, which must be differentiated from incomplete intestinal obstruction or an acute peritonitis.

#### PROGNOSIS

It is usually fatal unless there is surgical intervention. In Loewy's series of 26 cases, 11 patients who were not operated upon died.

#### TREATMENT

Since jejunal ulcers are the most important single entity as the cause of gastro-jejunal fistula, prophylactic measures are paramount. They may be outlined briefly as follows: (1) strict diet following gastroenterostomy, no smoking, alcohol or condiments; (2) proper administration of alkalies; (3) moderation in habits and living. When the diagnosis of fistula is established, operation is indicated, losing little or no time in preoperative treatment. The water balance should be established and acidosis, if present should be combated. The operative procedure should be as simple as possible, each case making its own demand on the judgment of the surgeon. Operation may be a simple closing of the fistula and the undoing of the gastroenterostomy, or extremely radical with "bloc" resection of the part of the involved colon, jejunum and stomach.

It must be remembered, as Lahey points out, that the undoing of the gastroenterostomy leads to recurrence of the duodenal ulcer.

According to Loewy's statistics in 63 operations of all kinds, there were 61.9 per cent cures, 11.1 per cent definite recurrences, and 27 per cent deaths. Lahey's

mortality is given as 15 per cent. Of the 20 cases operated upon at the Mayo clinic, 4 partial resections of transverse colon were made; in 15, the fistula was closed; in 11, the old gastroenterostomy was cut off; in 4, a new one was made; in 2, the old gastroenterostomy was reestablished; in 3, partial resection of the jejunum was performed; in 2, pyloroplasty; in 1, jejuno-stomy and cecostomy. Five patients died; 2 following the resection of the colon for carcinoma, 1 from acute nephritis two years after operation, 1 from general peritonitis and bronchopneumonia, and 1 from indefinite cause.

#### CASE REPORT

A white male, aged thirty-six years, entered the Lutheran Hospital, Brooklyn, N. Y., on March 3, 1926, and was discharged March 25, 1936, three weeks after admission. His chief complaints were diarrhea with six to seven bowel movements every twenty-four hours; lost sixty-one pounds in weight during the last two years; extreme weakness; normal appetite.

*Laboratory Data.* Red blood cells 4,410,000; hemoglobin 80 per cent; white blood cells 9400; polymorphonuclears 68; lymphocytes 26; eosinophils 1; basophils 1 and monocytes 4 per cent. The urine was negative. The blood Wassermann and Kahn tests were negative; blood sugar 72.2; non-protein nitrogen 33.8; creatinin 1.46 mgs. per 100 c.c. Gastric analysis reported from Queens General Hospital showed a normal curve. His stools were negative for ameba. His blood pressure was 92/66. Patient now weighs 114 pounds, is emaciated and dehydrated.

*Physical findings* are negative, except for an old upper right rectus incisional scar, three inches long.

*Past History.* In April, 1922, he had a duodenal ulcer, for which a posterior gastroenterostomy and appendectomy were performed at the Mare Island Hospital, California, May 2, 1922. After three months he was discharged having made an uneventful recovery. He enjoyed good health up to two years ago when he suddenly began to have diarrhea, six to seven stools a day, not accompanied by any pain, tenesmus, blood, or mucus in the stools. There was no nausea or vomiting. The stools were liquid mostly. He was seen in May, 1935, and while under treatment, was free from

diarrhea for three months, having only two formed stools daily and gained thirty pounds in weight. In August, 1935, his diarrhea reappeared and he entered the Lutheran Hospital, August 5, 1935, stayed one day and left, no work-up being done. In February, 1936 he entered the Queens General Hospital where a work-up was done and an x-ray diagnosis of "fistula connection between splenic flexure of the colon and greater curvature of the stomach" was established by Dr. Startz.

The patient returned to Dr. Morsch, to whom we are indebted for this interesting case. He was admitted to the Lutheran Hospital on March 3, 1936, with the mentioned history, Dr. A. L. Voltz confirming the previous x-ray diagnosis. On March 13, 1936, the operative findings showed a normal gall bladder, apparently normal stomach and duodenum with no evidence of the old duodenal ulcer but there was a posterior gastroenterostomy, at the anastomotic line of which, close to the greater curvature of the stomach, a fistula into the transverse colon three-fourths inches in diameter was found. The stoma at the enterostomy easily admitted two fingers. There were a moderate amount of adhesions. Sharp knife dissection of fistulous tract was performed with closure of the colon and reestablishment of the gastroenterostomy. Section of the fistula taken for biopsy was reported as "normal gastric mucosa."

His convalescence was uneventful, except that on the fourth postoperative day, he developed an acute catarrhal otitis media in the right ear. This had subsided before his discharge, twelve days postoperative. He had gained six pounds and his bowels were moving once a day.

In a follow-up three months later, the patient gained forty-six pounds; he has no complaints; his bowels are normal and he has resumed his usual duties.

#### SUMMARY

1. One should suspect a fistula in the presence of a persistent diarrhea following

an operation for gastric or duodenal ulcer, associated with loss of weight, fecal vomiting and eructation of foul smelling gas, intestinal obstruction being ruled out.

2. Jejunal ulcer occurred in 1 to 3 per cent of all ulcer cases for which a gastroenterostomy had been performed. Of these, 10 per cent ultimately developed gastrocolic fistulas.

3. Once an ulcer patient, always an ulcer patient, regardless of the type of surgical treatment.

4. Postoperative gastric cases should be impressed that they must continue under strict medical supervision the rest of their lives. Habits are restricted, particularly the use of tobacco, and perhaps, alcohol.

#### REFERENCES

- BALFOUR, D. C. and DOWN, H. I. *Surg. Clin. N. Am.*, 11: 740-742, 1931.  
 BETTS, ARTHUR. *Northwest Med.*, 29: 509, 1930.  
 BRAMS, W. A. and MEYER, K. A. *Surg., Gynec. and Obst.*, 38: 646-649, 1924.  
 DICKSON, W. H. *Can. Med. Assn. Jour.*, 18: 272, 1928.  
 GLICKMAN, L. G. *Radiology*, 23: 609-614, 1934.  
 GOLOB, MEYER. *Am. Jour. Surg.*, 8: 1007-1009 (May) 1930.  
 GREENLEE, D. P. *Proc. Staff Meet., Mayo Clinic*, 11: 146, 1927.  
 LAHEY, F. H. and JORDAN, S. M. *Ann. Surg.*, 77: 231-244, 1928.  
 MACDONALD, I. *Lancet*, 11: 804-806, 1927.  
 MASON, I. T. and BAKER, J. W. *Surg. Clin. N. Am.*, 11: 1097-1099, 1931.  
 MAYO, C. H. *J. A. M. A.*, 78: 433-437, 1922.  
 MONROE, R. T. and EMERY, E. S., JR. *New England Jour. Med.*, 128: 550, 1928.  
 POYNTON, F. I. *Lancet*, 11: 240-241, 1930.  
 PRATT, G. P. *Ann. Surg.*, 77: 433-437, 1923.  
 SHANGLE, M. A. and BEISLER, L. G. *Surg. Clin. N. Amer.*, 6: 1647-1652, 1926.  
 SHORE, B. R. *Ann. Surg.*, 87: 578-580, 1928.  
 STENHOUSE, H. M. *J. A. M. A.*, 82: 1926-1927, 1924.  
 PRATT, G. P. *Med. Clin. N. Amer.*, 12: 307-317, 1928.  
 VERBRUGGE, J. *Arch. Surg.*, 11: 790-808, 1923.  
 WATTERS, W. and PRIESTLEY, J. T. *Proc. Staff Meet., Mayo Clinic*, 8: 339, 1933.  
 WIESE, H. W. *Radiology*, 16: 477-482, 1931.  
 WILBUR, D. L. and EUSTERMAN, G. B. *J. A. M. A.*, 102: 364-366, 1934.



# SYMPATHECTOMY FOR HIRSCHSPRUNG'S DISEASE AND POLYPOSSIS

CLAUDE E. McCARTY, M.D., F.A.C.S.

Surgeon, St. Anthony's Hospital

DODGE CITY, KANSAS

THE gratifying results of sympathectomy in the relief of Hirschsprung's disease recommend this surgical procedure in many cases and suggest its further efficacy in the treatment of conditions arising from obstipation.

CASE I. W. A. a girl, nine years of age, was admitted to the hospital April 23, 1935. Her maternal grandparents were tuberculous. This child was four days old before a movement of the bowels could be produced by glycerine suppositories and Epsom salts. She had never had a natural evacuation and suffered frequent periods of complete obstipation. Diet had failed to affect this condition in any way. Salts and glycerine enemas produced only weekly or biweekly bowel movements.

Her abdomen was pendulous and greatly distended; the colon could be easily outlined. The urinalysis was entirely negative.

*Operation.* April 24, 1935. A midline incision was made below the umbilicus. The colon was found to be 3 inches in diameter with overdeveloped muscular coats. The length was increased and the colon felt thick and heavy throughout. The appendix was removed. The posterior peritoneum was incised vertically to the origin of the inferior mesenteric artery. Sympathectomy according to Rankin,<sup>1</sup> "The presacral nerve is divided at the right border of the left common iliac vein. . . . It is then raised upward by gentle dissection and the branches which reach it from the fourth lumbar ganglia are divided on each side . . . The connecting branches from the third lumbar ganglia are divided as they pass to join the nerve from beneath the common iliac arteries. When the nerve has been raised a little higher its lateral roots may be severed . . . " The two principal roots of the inferior mesenteric plexus were resected and the peritoneum closed. The abdominal incision was closed layer by layer, leaving 1000 c.c. normal saline solution in the peritoneal cavity.

The patient's bowels moved satisfactorily without enema the second day after operation. Convalescence was uneventful and she was discharged May 4, 1935.

Four weeks later the patient reported three bowel movements daily without medicine of any kind and June 6, 1935 she reported two natural bowel movements daily. A year later the patient was in excellent health and had been attending school regularly. She was having two daily natural bowel movements.

CASE II. D. S. A young single woman, twenty-two years of age, was admitted December 5, 1935 with complete intestinal obstruction. Family history negative. This girl had menstruated once at twelve years and not again until fourteen; since then the interval is four weeks, duration seven days, amount excessive. She complained of severe pain that necessitated remaining in bed for seven days preceding the period and for two days after onset.

She gave a history of constipation of a year's duration, relieved only by enemas which, during the last month, had caused severe cramping. X-ray findings revealed an obstruction in the sigmoid flexure, filling defect of 2½ inches and gross polypoid involvement of the entire colon, sigmoid and rectum.

Because of the youth of this patient it was hoped that the semi-invalidism subsequent to extensive colon resection might be avoided. As an effort in this direction it was decided to attempt to relieve her condition by means of sympathectomy and x-ray therapy, leaving future colon resection contingent upon the results.

*Operation.* December 10, 1935. A left rectus incision was made from the level of the umbilicus to the pubis. The peritoneal fold across the sigmoid holding the sigmoid to lateral abdominal wall produced a kink causing partial obstruction. There was a small adhesion between the ileum and the uterus. The fold in the side peritoneum was lengthened about 1½ inches by cutting across and suturing

<sup>1</sup>RANKIN, BERGEN and BUIE. *Diseases of Colon, Rectum and Anus*. Phila., W. B. Saunders & Co.



transversely. The adhesion between the ileum and the uterus was removed. The posterior peritoneum over the sacral prominence was

reported one or two bowel movements daily without laxatives. Her menstruation is normal and painless.

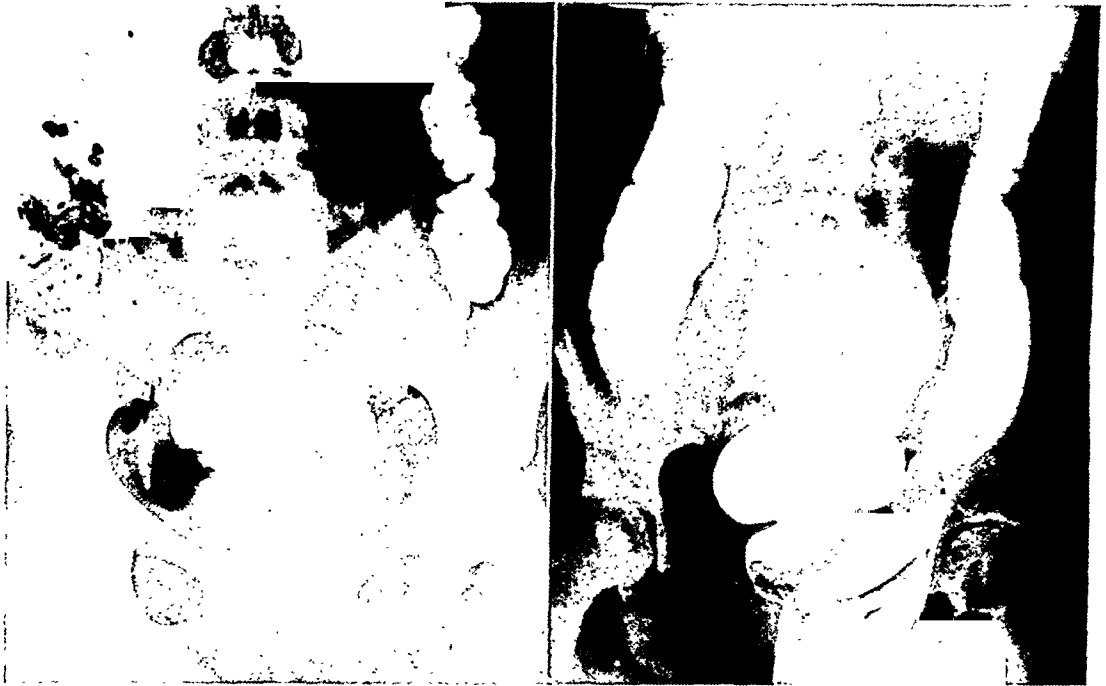


FIG. 1. Case of polyposis; A, before treatment; B, after treatment.

incised and the presacral nerve with the connecting branches resected.

The patient's convalescence was uneventful. On January 3, 1936, she was given x-ray therapy and discharged.

Her next menstrual period was normal as to flow and painless.

On February 16, 1936 she was readmitted with complete obstruction caused by released polypoids temporarily lodged in the sigmoid colon. The intestinal tract was emptied with Levin's duodenal tube. On February 20 the patient passed large polypoid masses from the bowel. Bowels moved normally without medicine or enema. The patient was discharged.

X-ray examination on March 12, 1936 revealed a normal colon. June 1, 1936 the x-ray studies showed a normal colon. The patient

These reports are submitted as suggestions for the possible relief of these conditions without radical surgery.

#### SUMMARY

1. Hirschsprung's disease can be cured by sympathectomy. Aggravated cases of long duration often yield rapidly and satisfactorily to this treatment, presenting strong evidence in its favor.

2. Sympathectomy plus irradiation is a safe and rational procedure in the attempted relief of polyposis.

3. Sympathectomy does cure certain types of dysmenorrhea.



# COMBINED ROENTGENOTHERAPY AND ULTRA-SHORT WAVE

ISIDORE ARONS, M.D. AND BORIS SOKOLOFF, M.D.

NEW YORK

THE problem of increasing the radiosensitivity of malignant tumors has long been recognized as of primary importance in the treatment of cancer and has been approached from various aspects and angles. Gottwald and Schwarz<sup>1</sup> had shown that radiosensitivity depends in a large degree on the blood supply of the tissue, active arterial hyperemia effecting an increase of the radiosensitivity. Studying heating effects resulting in a local hyperemia, Rohdenburg and Prime<sup>2</sup> employed diathermy to heat in vitro the tumor cells and followed this with roentgen ray irradiation. They succeeded in obtaining more positive results by combined technique. Liebesny<sup>3</sup> was also able to produce a similar destruction of mouse carcinoma by means of diathermy alone, with only a partial and temporary destruction. Teilhaber,<sup>4</sup> Schwarz and Berndt, and Mueller,<sup>5</sup> using diathermy combined with roentgenotherapy in treating malignant tumors, reported favorable results. Nevertheless the combined technique has not found adaptation in general practice.

Since the introduction of short wave and ultra-short wave apparatus, numerous attempts have been made to utilize this agency for treatment of neoplasms. Scherschewsky<sup>6</sup> was the first to report the results of experiments on transplanted mouse sarcoma. In using ultra-short waves of 3 meter length the growth of the tumor was inhibited, and complete disappearance of the growth resulted in a few cases. Pflomm,<sup>7</sup> conducting a series of very precise experiments on Jensen rat sarcoma, found that under the short wave treatment of 4.5 meter length the tumor ceased to grow almost at once and later became reduced in size and necrobiosed. Histologic examination showed marked capillary hyperemia

with a free transudation of blood at the periphery of the tumors, and a migration of parietal leucocytes through the vessel wall. Some thrombosis had occurred in the tumor vessels and finally focal necrosis was also observed over the entire area.

Reiter,<sup>8</sup> experimenting on Jensen sarcoma and Flexner carcinoma with short waves ranging from 3 to 15 meter length, stated that this irradiation has a specific biologic effect conditioned by the wave length, and is most apparent with waves under 4 meter length. A heavy dose produces a dilatation of the blood vessels. Histologic study of the treated tumors showed that wave length of 3.5 meters proved to be the most destructive.

Reiter<sup>9</sup> later investigated the effect of short waves on cell metabolism, and found that with a wave length of 3.4 meters there was a marked suppression of anaerobic fermentation of sugar, of as much as 80 or 90 per cent. In this particular, short wave irradiation differs from x-rays in that the action of the latter shows no effect on anaerobic metabolism. He excludes the effect of raised temperature as the possible factor responsible for this specific biologic action. His general conclusion is that the primary action of the short waves is on the metabolism of the cell directly, while x-rays interfere with the metabolism only through the direct damage to the cell itself.

Roffo<sup>10</sup> demonstrated that waves ranging from 0.58 to 6.75 meter length inhibit the growth of rat sarcoma in vitro, but not that of the embryo chicken heart. The irradiated rat sarcoma failed to take in an average of 40 per cent of the animals, as compared with the 100 per cent take in the non-irradiated grafts.<sup>11</sup> The irradiated grafts which did survive grew much more slowly than the controls.

Hill<sup>12</sup> investigated the growth of Jensen rat sarcoma with a weak dose of ultra-short waves alone, and also in combination with radium treatments. Evidence was obtained that ultra-short wave irradiation made the tumor more sensitive to radium, although either agent was ineffective when used alone, and the weak dose of ultra-short waves was too small to cause any serious injury to normal cells. There was also no rise in temperature to a degree which in itself might be lethal.

Mortimer and Osborne,<sup>13</sup> however, stated their belief that "heat alone was responsible for the therapeutic effect which the short wave generators produce." Hasche and Collier<sup>14</sup> found no evidence of a retarding effect on the growth of the tumor when Ehrlich mouse sarcoma *in vitro* was exposed to 3.5 meter waves. Eidinow<sup>15</sup> is also of the opinion that there is no specific action of the ultra-short waves of 3 and 4 meters. He believes that all ultra-short waves appear to act in the same way as the diathermy currents of longer wave lengths, which is by heating the tissues. Haas and Lob,<sup>16</sup> and in a later paper, Lob,<sup>17</sup> disclaim any specific action on the tumor by the short waves. Experimenting with the Jensen mouse sarcoma and carcinoma, they have observed no other action except a heating effect on the tumor. All their attempts to treat malignant tumors with short wave irradiation have given negative results. More recently, Dickens, Evans and Weil-Malherbe,<sup>18</sup> studying the effect of ultra-short waves on cancer tissue *in vitro*, concluded that only heat is responsible for the destructive effect of this irradiation.

The results obtained by Schliephake,<sup>19</sup> who used short wave treatments combined with x-rays in carcinoma of the uterus, seemed to be uncertain. He used two electrodes opposite each other, one plate over the uterus and another over the sacrum. Later he modified this technique using an internal vaginal electrode because of the pains produced in the sacrum. Wave lengths of 6 and 15 meters for forty minutes

were employed. After several treatments a marked disintegration of the carcinomatous tissue was observed, but on stopping the treatments for a period of several weeks, the growth recurred.

The first detailed and thorough report on the combined short wave and x-ray therapy came recently from Fuchs,<sup>20</sup> who reported the work done at the City Hospital in Vienna. Liebesny's technique for application of short waves was followed, in which the heating factor is eliminated, the treatment being based on the specific electrical reaction only. The electrode-skin distance was at least 10 cm. in order to produce the desired depth effect; 15 meter wave length was used and the treatment lasted twenty minutes. X-ray therapy was applied a few hours after the short wave irradiation. Fuchs states that the combined technique produced no increase in the tumor growth and had no effect on the skin reaction with the Coutard technique. He believes that the combined technique is of eminent value in the treatment of neoplasms and urges its application in x-ray clinics.

#### TECHNIQUE

The biologic premises for this work are based on the non-thermal properties of short wave therapy.

According to investigation by Pflomm<sup>21</sup> and confirmed by Liebesny and others, the ultra-short waves possess a strong vasodilatory action. In Pflomm's experiments on frogs, after an application of U.S.W. there exists a marked vascular dilatation, especially of the capillaries, which remains for a few hours.

Pflomm pointed out that the temperature in the region treated did not rise above 26 or 27 degrees C. and that by simple heating none of these effects could be produced, except a very insignificant one of short duration. This specific athermic action was demonstrated by a series of experiments with adrenalin. The thermal stimulation was more or less completely

annihilated by adrenalin, but athermal dilatation remained unchanged.

Liebesny in his recent monograph<sup>22</sup> concluded that heat is not only useless but might be harmful. He avoids heating of the skin by increasing the air space between the skin and the electrode. Heating of the deep-lying tissues should be reduced by using a very weak intensity of current.

In applying short waves, their bacteriocidal action and analgesic effect should also be taken into consideration. Short wave treatments were found to be useful in relieving pain, the effect being quite lasting. As a rule, in cancer patients with infection, five daily short wave treatments preceded the combined course of treatments. Also in a series of postoperative cases with persistent suppuration, and in the erythemas of roentgenotherapy, short waves were found helpful.

For our work a short wave apparatus of 6 meter wave length and approximately 250 watt capacity was used, with circular rubber-protected condensor electrodes, 10 cm. in diameter and a skin-electrode distance of 7 to 12 cm., the "active" electrode having the shorter air space. In order to duplicate approximately the same dosage in each treatment: (1) the electrodes were adjusted to the same position at the same distance from the skin, (2) the same voltage setting was used as previously employed, and (3) an endeavor was made to obtain the same reading on the so-called high frequency milliamperemeter, which is a more or less arbitrary scale. In the beginning we attempted to determine the exact number of watts actually required for each treatment. A milliammeter was put in the plate circuit of the apparatus which thus indicated the current absorbed for actuating the oscillation. The milliamperes used by the patient were determined by first noting the number of milliamperes on the meter with the patient in the short wave field. The patient was then removed from the field and the drop in the milliamperereading was taken to constitute the number of milliamperes used by the pa-

tient. This number was multiplied by the number of volts (from the voltage setting) used and the result calculated in watts.

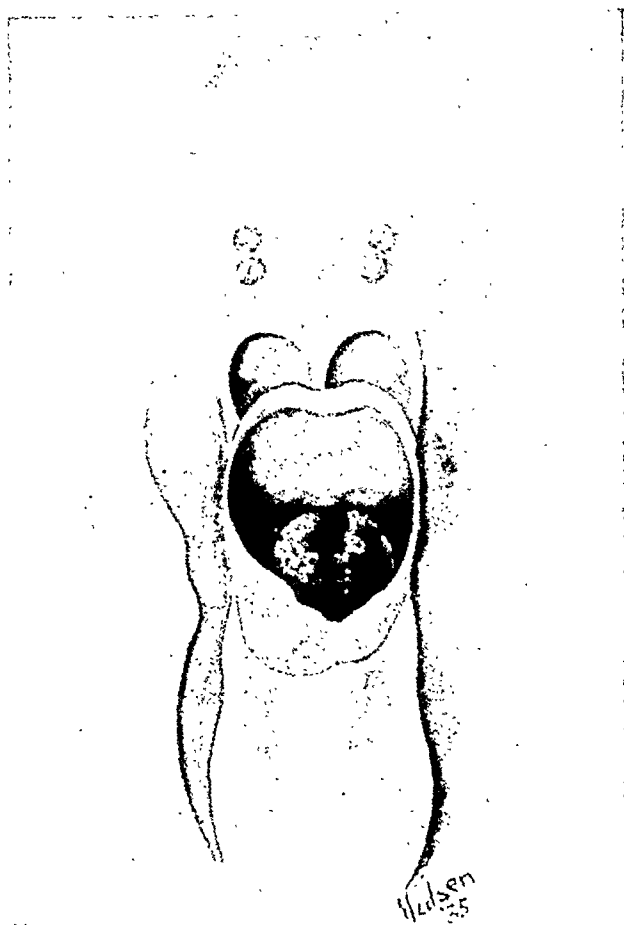


FIG. 1. Case 1. J. K., aged sixty-eight years; generalized laryngeal carcinoma, extrinsic and intrinsic. Received 30 x-ray treatments, divided into 2 treatments daily, right and left; total of 3000 r to each side. Treatment combined with short wave therapy.

While this procedure gave some definite expression of the dosage, yet as far as duplication of the dosage was concerned, we found that we were able to obtain fairly identical conditions by adhering to the procedure first mentioned, measuring the air distance, etc. In every case we tried to avoid raising the temperature of the part treated, both by keeping the air space between the electrode and the skin fairly wide, and by limiting ourselves as much as possible to the lower voltage settings. The usual length of each treatment was fifteen minutes.

These ultra-short wave treatments were combined with the Coutard technique of roentgenotherapy. The short wave treatments were given either shortly before or

in between the two halves of a daily x-ray dose. The patient's general condition was checked by frequent blood counts and

November, 1935. Laryngoscopy revealed a generalized laryngeal carcinoma, combined extrinsic and intrinsic, with a free peduncu-

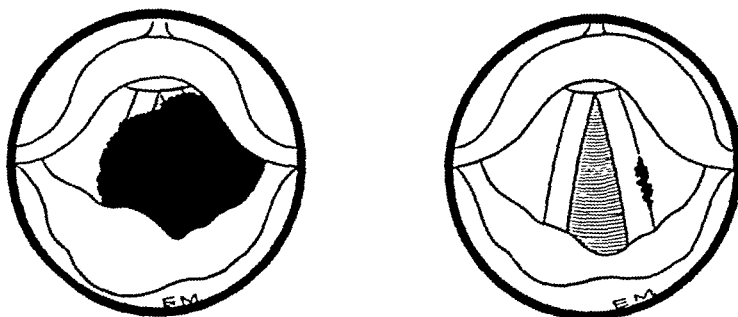


FIG. 2. Case 1. Examination one month later; epiglottis much freer and movable but much thicker on its left half; right side of epiglottis still thick but movable. The vocal cords are more pliable, the left still presenting some cauliflower appearance and thicker than the right side. The right cord is normal.

Subsequent history—patient is gaining weight, feeling well and voice is normal.

physical examinations. We also attempted to keep a check on the progress of treatments by doing Vernes'<sup>23</sup> flocculation tests for malignancy.\*

#### CASE REPORTS

During the last year 30 cases of malignancy were treated with the combined techniques of Coutard and the ultra-short waves. For our observations different localizations of the malignancy were selected: carcinoma of the oral cavity, of the larynx, of the epigastrium, of the uterus, and of the rectum. These cases may be divided into two series, (1) those of the radiosensitive and (2) those of the radio-resistant type of tumor. In addition to these, there were 4 postoperative cases, in which the tumors were removed by surgery but suppuration of the incision resisted ordinary means of treatment.

#### FIRST SERIES: RADIOSENSITIVE TUMORS

CASE 1. J. K., aged sixty-eight years, male, had always been in good health previous to the onset of hoarseness and hemoptysis, occurring about one week prior to the examination in

lated mass, about 2 cm in diameter, arising from the left vocal cord and extending to the right cord. It was dark brown and somewhat cauliflower in appearance with a few ulcerations in its mesial surface and formed a shelf-like area in the posterior portion of the larynx. There was considerable edema associated with the tissue swelling (Fig. 1).

The patient received a total of 6000 r in fifteen sittings over a period of six weeks, 200 r over each of the two fields with 1 mm. Cu. + 2 mm. Al., at 50 cm. distance. Ultra-short wave treatments were given before and in-between the two halves of the daily dose of x-rays.

Laryngoscopy after four weeks of combined treatment revealed considerable improvement. The epiglottis was much freer and more movable, and the vocal cords were more pliable. The left cord still presented some cauliflower appearance but the right cord was decidedly more normal. The patient's general condition was satisfactory, a gain of several pounds having been recorded (Fig. 2).

The combined course of therapy was followed by several treatments of short wave alone. Examination three months later demonstrated the disappearance of the mass, though some impairment of movement on both sides still remained. Hoarseness became much less pronounced.

\*The Vernes' flocculation test for malignancy is a serum flocculation test. Various dilutions of copper acetate are used and the flocculation value is determined by means of a special photometer.

Remarks. Biopsy revealed a radiosensitive epidermoid carcinoma, Grade III, which responds with good results with the

Coutard technique alone. Prior to the treatment there was considerable edema of the larynx, nevertheless, the combined

at the left epiglottic border with some discharge from a crater-like lesion and which elevated the left cord slightly.

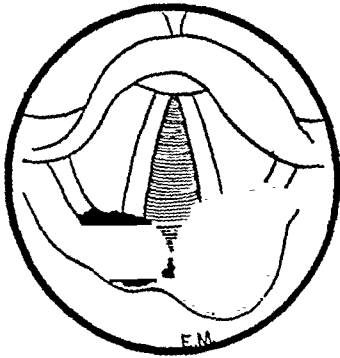


FIG. 3.

FIG. 3. Case II. W. B., aged sixty-six years; squamous cell carcinoma of larynx, Grade 1. December, 1935 the lesion is located in the region of the left arytenoid and extends to the left ary-epiglottic and glosso-epiglottic folds, and downward on the posterior surface of the larynx into the cricoid region where there is a large ulceration. The left cord is partially concealed by the growth. There is some infiltration of the left vallecula.

Received 30 x-ray treatments, divided into 2 daily treatments of 200 r each combined with short wave therapy.

FIG. 4. May, 1936, the patient gained weight and his speech is normal. There is thickening and irregularity with scar formation of the anterior epiglottis; there is thickening of the left posterior epiglottis. The vocal cords appear normal.

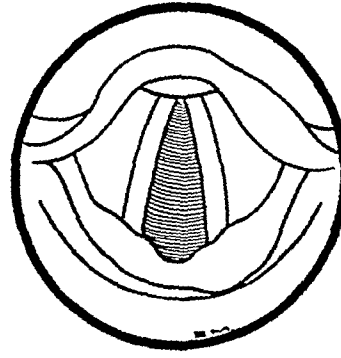


FIG. 4.

treatment did not increase the edematous condition. There was distinct, deep burning of the skin but no peeling occurred, nor any necrosis of the cartilage observed.

CASE II. W. B., aged sixty-six years, male, complained of hoarseness and cough for about a year. Examination of his throat in January, 1936 showed a lesion located in the region of the left arytenoid, 2.5 cm in diameter, and extending to the left epiglottic field and extended downward on the posterior surface of the larynx into the cricoid region, at which point there was a large ulceration. The left cord was partially concealed by the growth. There was also some infiltration of the left vallecula. While the lesion extended to the right side the main infiltration was located in the left pyriform sinus (Fig. 3). No lymph nodes were palpable in the neck. The pathological report of the biopsy was cornifying carcinoma Grade 1 in Broder's classification.

The patient was treated by the combined technique and received a total of 7200 r of radiotherapy, 3600 r on each side.

Examination four weeks after starting the treatments showed considerable regression in neoformation, except for a small greyish area

A reexamination four weeks later showed further regression in the growth, except for a very small area at the left epiglottic border which showed a grey membrane, apparently the remains of the irradiation effect rather than the remnant of cancerous growth. Laryngoscopy in June, 1936 revealed no evidence of malignancy, the vocal cords appeared normal, though some thickening still remained on the left of epiglottis (Fig. 4).

*Remarks.* This case is similar to the preceding one, the tumor being of the radio-sensitive type. In general, the patient went through the treatment much more easily than did the patient in Case I.

In considering the cases of the radio-sensitive type of tumor, the combined treatments showed no disadvantage over the Coutard technique alone. However, the skin irritation appeared to be less pronounced in the combined therapy.

#### SECOND SERIES: RADIORESISTANT TUMORS

CASE III. J. B., aged sixty-four years, male, had an exploratory gastrostomy performed in

May, 1935 which revealed a diffuse induration on the lesser curvature of the stomach at the cardia, extending well into the esophagus, and

*Remarks.* It is premature to state anything about the results of the treatment in this case. However, considering that

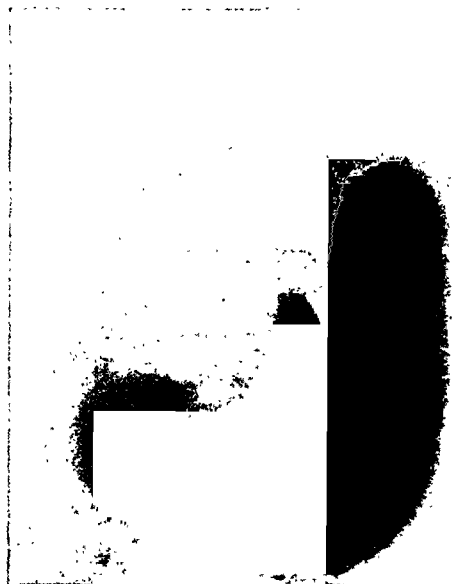


FIG. 5. Case III. J. B., aged sixty-four years; diffuse induration of the lesser curvature of the stomach at the cardia in November, 1935.



FIG. 6. Case III. June, 1936 after irradiation and ultra-short wave treatments.

involved the contiguous two-thirds of the posterior wall and the proximal third of the anterior wall. At that time it was diagnosed as inoperable carcinoma of the cardia of the linitis plastica type. Roentgenograms taken in November, 1935 revealed considerable proliferation of malignancy which had now affected the upper third of the greater curvature (Fig. 5). The patient had been suffering from stubborn pain which could be relieved only by opiates.

In February, 1936 the combined technique of roentgenotherapy and ultra-short waves were instituted. The patient felt much better after four weeks of treatment, the pain gradually decreasing in severity. The total dose received was 7800 r, divided over the anterior, posterior and lateral fields, with a distance of 70 cm.

Roentgenographic reexamination of the patient June 16, 1936, revealed considerable improvement in size and outline of the stomach. There was no evidence of irregularity in peristalsis, with the exception of a moderate retardation at the cardiac end. The patient has gained eight pounds but complains of occasional spastic pain in the epigastric area, after any intemperance in his dietary regime (Fig. 6).

less than 10 per cent of gastric carcinoma is of the radiosensitive type, and that this case is not a radiosensitive type of tumor, and in addition being in an advanced state, the improvement merits attention. In this case also, it was noted that the pronounced skin reaction which usually is manifested at 3000 r, appeared diminished (Pack and Scharnagel<sup>24</sup>).

CASE IV. E. H., aged sixty-eight years, female, had been complaining of pain in the epigastric region and of a loss of 20 pounds weight during the six weeks prior to her admission in November, 1935. Physical examination revealed a flat mass, 11 cm. in diameter, occupying the epigastric area, its upper border 2.5 cm. above the umbilicus. Radiologic examination showed a large constant filling defect chiefly along the lesser curvature and posterior aspect of the pars media and pylorica of the stomach, giving the typical appearance of an adenocarcinoma (Fig. 7).

The patient was treated by the combined therapy, receiving 1200 r of x-ray radiation over each of two fields within a period of eight days. A second cycle of 1800 r was administered in

March, 1936, over each three fields within two weeks.

Re-examination in March revealed an almost

esophagus, which was caused by an obstruction of the cardio-esophageal junction, and permitted only a sluggish passage of the barium



FIG. 7. Case iv. E. H., aged sixty-eight years; radiological examination, November, 1935, shows constant filling defect along the lesser curvature and posterior aspect of the pars media and pylorica of the stomach.



FIG. 8. Case iv. March, 1936 following treatment with combined roentgenotherapy and short wave.

normal appearance of the outline of the lesser curvature with the exception of a sluggish peristalsis (Fig. 8).

At present the patient appears to be in good condition, has no complaints, and has gained seven pounds in weight. The treatments were given in divided doses, twice daily, short wave treatments given in between the x-ray therapy. The treatments were well tolerated with exception of an occasional mild nausea. The skin reaction appeared to be diminished in its intensity.

**Remarks.** The results in this case are interesting, considering the radioresistance of the gastric adenocarcinoma. However, it is too premature to draw any conclusions.

**CASE V.** S. W. aged forty-four years, male, was admitted for treatments in April, 1936. The onset of disease dated back six months with nausea and vomiting, and of loss of weight and of appetite during this period.

X-ray examination revealed a dilatation forming a pouch in the middle third of the

meal. Esophagoscopy revealed that at the base of the esophagus there was an irregular, whitish, cauliflower-like appearance of the mucosa of carcinomatous origin.

Combined technique was applied. X-rays were given over three fields each totalling 3000 r, in two daily treatments of 200 r to each field. The short waves were applied in the interval between the two treatments. The skin tolerance was found to be markedly increased.

Considering the very high dosage administered, the nausea was noted to be less than one would ordinarily expect under these conditions.

Radiological examination in July revealed a widening of the upper portion of esophagus and sluggish peristalsis. At the lower third, the cardiac end passage was reduced to one-third of the normal width, but the meal passed without any obstruction or spastic reaction. The patient is still under treatment.

**CASE VI.** E. R., aged fifty-two years, female, has a history of cancer in the family. She had been complaining of a severe pain and rectal bleeding. X-ray examination in November, 1935, showed small circumscribed round shad-



ows scattered along the wall of the rectum and of the sigmoid, extending upward along the descending colon. Physical examination Decem-

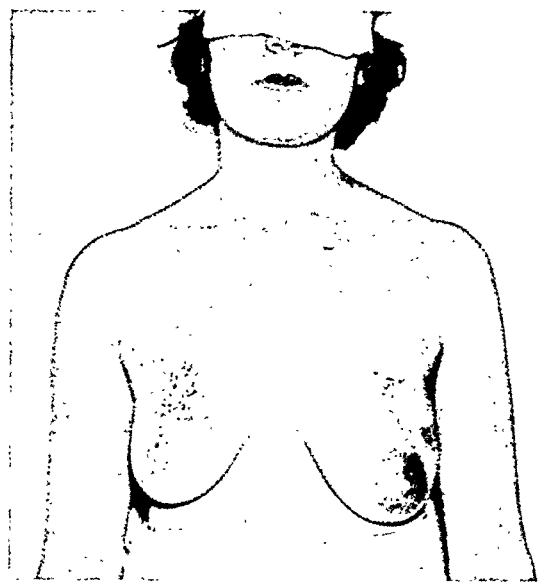


FIG. 9. Case VII. J. F., aged thirty-seven years; mammary carcinoma of both breasts. Postoperative healing progressed under short wave treatment.

ber 5, 1935, revealed a narrowing of the rectum about 4 cm. from the external canal which extended for a distance of about 4 cm. There was an indurated mass, polypoid in character, forming a distinct ridge. Diagnosis of carcinoma of the rectum, epithelioma of prismatic-cellular type, was made.

Combined treatments of x-ray therapy and ultra-short waves were begun on December 5, 1935. X-ray treatments, given over four pelvic fields, totalled 6000 r.

By January 14, 1936, the patient's condition seemed to be greatly improved, the pain had diminished and additional radium was implanted into the posterior wall of the rectum, totalling 2525 mghrs.

An examination March 30 revealed no palpable induration, and the patient's general condition was satisfactory. A re-examination in June, 1936 showed no change.

*Remarks.* Generally, carcinoma of the rectum does not give very satisfactory results with radiotherapy. Gordon-Watson<sup>25</sup> recommends surgical intervention for such cases. However, he reports a few inoperable cases of carcinoma of the rectum treated with satisfactory results by the Coutard technique. Tailhefer<sup>26</sup> emphasizes the diffi-

culties with radiotherapy of the rectum and the uncertainty of results. In this case it seemed that the tumor did not offer much resistance to the combined treatment. However, only time and repeated re-examinations of the patient, can show whether the results of this combined technique are of value in the treatment of malignancies of the rectum.

In radioresistant tumors, the combined technique offers some advantage over the Coutard technique alone, however, it is still too early to make any definite conclusion in this regard.

#### POSTOPERATIVE CASES

CASE VII. J. F., aged thirty-seven years, female, presented the following past history. In 1927 the right breast showed a palpable tumor 3 by 5 cm. Biopsy substantiated the diagnosis of carcinoma of the right breast. The patient was treated with x-ray therapy and radium and a complete disintegration of the tumor followed. Periodical examinations up to 1932 showed no recurrence.

However, in 1934 the patient returned, having noted a lump in her left breast. Examination revealed a tumefaction in the left breast, 6.5 cm. in diameter, at about 2 o'clock from the nipple. Pathological report by Dr. Ewing was that of carcinoma. Endocrine findings on the patient, were: "Ovarian hormone curve is within normal limits, prolactin curve is slightly and continuously high."

Radium application and x-ray therapy were instituted. The patient received a total of 1800 r, divided over four fields, and radium implantation totalling 3360 mghrs. and in September, 1935, the remaining mass was excised. The specimen was oval shaped, 5 cm. in length, 3.5 cm. in width, with a depth of about 4 cm., and consisted of fibrotic tissue. The area around this mass did not appear diseased, nor were any tumefactions palpable. Pathological report of the specimen was negative for malignancy.

Suppuration from the incision persisted for three months, notwithstanding insertions of drains and frequent irrigations. In December, 1935 ultra-short wave treatments were begun, being applied three times a week for fifteen minutes. Healing progressed and was practically complete by the end of February (Fig. 9).

The patient was discharged and advised to present herself for periodical examinations.

*Remarks.* This case is presented to demonstrate the value of ultra-short wave treatments in postoperative healing.

CASE VIII. H. S., aged forty-two years, female, had a history of having a lump in the region of the left parotid since childhood.

Father of the patient died of cancer of the throat. In 1933 the growth increased in size and a parotidectomy was done in August of that year. The tumefaction was flattened in contour and about 1 cm. thick. Pathological report revealed an "infiltrating carcinoma with prominent glandular feature." In February, 1935, a recurrence of the tumor was noted and the patient underwent a second operation in May, 1935. Radium implantation totalling 2000 mghrs, and x-ray treatments totalling 2000 r, were given postoperatively. Diathermy was also applied to decrease the pain, but without much success.

A persistent discharge from the incision and a continuous pain in the region, led to starting a series of ultra-short wave treatments, beginning December 12, 1935. By January 15, 1936, after ten treatments of fifteen minutes each, the wound had completely healed. However, after stopping the treatments for one month, the patient returned claiming that she had less pain while she was receiving the treatments. At the present time, an occasional treatment is given, and the patient's condition is satisfactory.

*Remarks.* This case demonstrated the analgesic effect of the ultra-short waves.

#### DISCUSSION

Radiosensitivity of cancer cells cannot be considered as constant at all times. It varies in relation to the physiological condition of the cells which exist at the time of irradiation. Crabtree and Cramer<sup>27</sup> have shown that radiosensitivity is not a fixed property of malignant cells, but varies with the changes in environment. It is evident that in the light of these findings, the question as to the exact phase in which the cells are most sensitive to irradiation begins to lose some of its reality.

Susceptibility of the dividing cells depends on the physiological state of mitosis

which offers a more favorable condition for ionization, which, according to Lind<sup>28</sup> is the initial cause for the chemical reactions which are set up by radiation. The problem, precisely which cellular phase is the most sensitive, whether metaphase, telophase, or prophase, is of little practical value.

It seems to be a rule that those cancer cells of the embryonic type, which have a considerably high (1:3) nucleoproteoplasmic ratio are the most radiosensitive. It is known that tumors showing a high degree of anaplasia and forming diffuse infiltrating growth are composed of such cells. The tumors in which the cells are of the adult type with the N-P ratio approaching that of normal adult cells (1:6) have the tendency to keratinization and are the most resistant to irradiation. So that from the cytological point of view, it may be possible to say that a high N-P ratio of cells is an indication of their susceptibility to irradiation (Sokoloff<sup>29</sup>).

But dealing with tumors, one might find other factors involved, which sometimes interfere with cellular susceptibility, the importance of which has already been recognized by some radiotherapists. If we admit that sensitivity to irradiation is increased when there exists a rapid increase in respiratory metabolism,<sup>30</sup> we are justified in making an attempt to increase the metabolism in neoplastic tissue before and during the irradiation. One of the means of increasing respiratory metabolism is by augmenting the blood supply through hyperemia and vasodilation. In this sense, ultra-short wave offers a convenient and simple technique. Wherever there was a possibility of a direct observation of the treated tumor, as in larynx patients, a pronounced hyperemia of the tumor itself was noted from the first days of the short wave treatments. This hyperemia has never been observed to such a degree in patients treated by roentgenotherapy alone.

However, the ultimate effect of radiation depends on the power of recovery of

the cells, which in its turn depends on the blood supply. This fact, of prime practical importance, is often neglected by laboratory investigators, who arrive at a generalized conclusion from their experiments *in vitro*.

Thus the experiments with chick embryos show that the effects *in vivo* are not exactly similar to those obtained *in vitro*. The response to radiation varies according to the presence or absence of a blood supply (Spear<sup>31</sup>). When the blood supply is normal, recovery is favored, but if the blood vessels are injured by irradiation, a generalized destruction follows. This is demonstrated by the experiments of Strangeways and Fell in cases of chick embryos. If the embryos are irradiated before the blood vessels have appeared, they are capable of tolerating much greater doses of radiation than after the vascular system is developed.

There are also indications that endothelial and subendothelial tissues are highly sensitive to irradiation (Colwell<sup>32</sup>), which probably plays a considerable role in the destructive effect of irradiation on vessels of the tumor. In this sense, this effect of short waves may facilitate the obliteration of blood vessels of the tumor by x-rays. Pflomm was able to demonstrate this effect by obtaining a complete temporary stoppage of the blood stream in the smallest veins and in the capillaries of frogs by using ultra-short waves of 4 meter length. Continuance of action produced thrombosis. Naturally, in the small doses that are used in practice, this effect is not to be expected in the short treatments used, but it is possible that the combined effect of short waves and of x-rays may produce a more damaging effect on the tumor.

In the limited space of time which has elapsed from the start of our investigations, we cannot as yet form any definite conclusions concerning the increase of radiosensitivity of the tumors treated by the combined technique. However, observing some 30 cases for a period of

one year, our impressions are that the method is of value. In our experience there has been no case whose condition was aggravated by the combined treatment. It has been noted that skin injury from irradiation seems to be decreased when short waves are used in conjunction with the irradiation, but again, no definite claim can be made until more patients have been observed.

#### CONCLUSIONS

1. Combined treatment of Coutard technique of roentgenotherapy and ultra-short wave (6 meter length) has been applied to 30 cases of malignancy, avoiding as much as possible the thermal effect of the short wave.
2. There was no indication that ultra-short waves aggravated or stimulated neoplastic tissue in any of the cases.
3. It is premature to draw any definite conclusions as to whether the vasodilatory action of these ultra-short waves increases the radiosensitivity of the tumor.
4. Lessening of skin injury by x-rays was observed in some of the patients, but more studies must be made in order to draw any definite conclusions.
5. Short waves were found to be of distinct benefit in postoperative suppurations.
6. Analgesic effect was obtained in some cases when treated by ultra-short waves.

#### REFERENCES

1. SCHWARZ and GOTTWALD. *Muench. med. Wchnschr.*, 56: 1210, 1910.
2. ROHDENBURG and PRIME. *Arch. Surg.*, 2: 116, 1921.
3. LIEBESNY, P. *Wien. klin. Wchnschr.*, 34: 117, 1921; 47: 55, 1934; "Kurz und Ultra-kurzwellen," Berlin, Vienna, Urban u. Schwarzenberg, 1935, p. 138ff.
4. TEILHABER. *Berl. klin. Wchnschr.*, 50: 348, 1913; *Wien. klin. Wchnschr.*, 32: 749, 1919.
5. MUELLER, C. *Muench. med. Wchnschr.*, 57: 1490, 1910; *Strahlentherapie*, 10: 749, 1920.
6. SCHERESCHEWSKY. The action of very high frequency upon a transplanted mouth sarcoma. *Public Health Rep.*, 43: 937, 1928.
7. PFLOMM. Experimentelle u. klinische Untersuchungen über die Wirkung Ultrakurzer elektrischen Wellen. *Arch. klin. Chir.*, 166: 251, 1931.
8. REITER, T. *Ann. d'Inst. Actinologie*, 7: 195-198, 1932.

9. REITER, T. *Deutsche med. Wchnschr.*, 59: 1497-1498, 1933.
10. ROFFO, A. E., JR. *Néoplasmes med.*, 42: 466-475, 1934.
11. ROFFO, A. E., JR. *Néoplasmes*, 12: 153, 1933.
12. HILL, L. *Brit. Med. Jour.*, 2: 370-371, 1934.
13. MORTIMER and OSBORNE. *J. A. M. A.*, 104: 1413, 1935.
14. HASCHE, E. and COLLIER, W. A. *Strahlentherapie*, 51: 309-311, 1934.
15. EIDINOW, A. *Brit. Med. Jour.*, 2: 332, 1934.
16. HAAS, M. and LOB. *Strahlentherapie*, 51: 345, 1934.
17. LOB. *Wschbr. Krebskpfsg.*, 3: 74, 1935.
18. DICKENS, EVANS and WEIL-MALHERBER. *Am. Jour. Cancer*, 28: 603, 1936.
19. SCHLIEPHAKE, E. *Short Wave Therapy*. London. The Actinic Press, 1935, p. 181.
20. FUCHS, G. *Strahlentherapie*, 55: 3, 473-480 (March 21) 1936.
21. PFLOMM, E. *Arch. klin. Chir.*, 166: 251, 1931.
22. LIEBESNY, P. *Kurz- und Ultrakurzwellen*, Vienna, Urban und Schwarzenberger, 1935.
23. VERNES. *Arch. Inst. Prophyl.*, 2: 211, 1930.
24. PACK and SCHARNAGEL. Palliative irradiation of inoperable gastric cancer. *Am. Jour. Surg.*, 31: 247-256 (Feb.) 1936.
25. GORDON-WATSON, SIR CHARLES. *Proc. Roy. Soc. Med.*, 28: 1251, 1935.
26. TAILHEFER. *Paris Med.*, 110: 254, 1933.
27. CRABTREE and CRAMER. *Proc. Roy. Soc. Med.*, 113: 225, 1933. See also Dobrovolskaya-Zavadskaya. *Radiology*, 19: 354, 1932.
28. LIND, S. C. *Am. Jour. Roentgenol.*, 21: 480, 1929.
29. SOKOLOFF, B. The nucleocytoplasmic ratio and cancer. *Jour. Cancer Res.*, 5: 7, 1922.
30. LAMBERT, K. Recherches sur les facteurs de la radiosensibilite. *Arch. Biol.*, 42: 42, 1935.
31. SPEAR, Brit. Jour. *Radiol.*, 8: 68, 1935.
32. COLWELL, H. *The Method of Action of Radium and X-rays on Living Tissue*. London, Oxford University Press, 1935.



It seems that infections of the pancreas occur more frequently than cysts or neoplasms. Carcinoma is the most common of the new growths. In 11,472 necropsies, Segre found 127 cases of carcinoma and two of sarcoma. Hale White found one case of sarcoma in 6708 necropsies. According to Deaver and Pfeiffer, carcinoma is the most frequent tumor of the pancreas, forming one per cent of all cases of carcinoma. The secondary are more frequent than the primary, coming from the stomach or biliary passages—10 per cent of gastric carcinoma extending to the pancreas—while the most common benign tumor is the cystadenoma.

Papers on Surgery and Other Subjects by George Tully Vaughan, M.D.

# NEW INSTRUMENTS

## A NEW INSTRUMENT AND TECHNIQUE FOR INTESTINAL ANASTOMOSES\*

JOHN R. O'SULLIVAN, M.D. AND BERNARD A. O'CONNOR, M.D., F.A.C.S.

KEARNY, N. J.

SOME years ago after an unfortunate and unsuccessful attempt to anastomose the ileum to the ascending colon for relief of an obstruction at the ileocecal valve, we became dissatisfied with the conventional type of intestinal clamp. We therefore embarked upon a series of mechanical and surgical experiments which after a long course of trials and errors resulted in the instrument and technique to be described.

Reduced to its simplest requirements the solution of this problem required an exhaustive study of the mechanical efficiencies of only two basic types of instruments.

1. The present type of two blade clamp with alterations in the length, breadth, flexibility of the blades as well as changes in the distance from the screw to the ratchet catch, the number and fineness of the teeth in the catch, all factors which determine how well or how ill the clamp will hold;

2. An adjustable tension device with mechanical fingers containing rubber inserts which grasp and hold the anastomosis under any predetermined and reasonable degree of tension compatible with easy and accurate suturing.

We secured a half dozen modifications of the conventional type long intestinal clamp. All possible modifications of the length, breadth and flexibility of the blades with respect to the position of the screw and catch were included in the designs. Using these clamps for our experiments we performed a considerable number of pos-

terior gastroenterostomies on dogs. Briefly stated, we found that within certain mechanical and surgical requirements and limitations, it is very difficult, almost impossible, to perfect a clamp which will exert a uniform non-traumatic grasp on the loops of bowel about to be joined together. Or, to state this conclusion in other words, no matter how one alters the conventional type clamp, with respect to the factors given, the total effect is that of a shearing force no different in its fundamental principle than that exerted by a pair of scissors. The segment of bowel nearest the screw, or fulcrum, will be firmly held, let us say almost crushed, while the outer portion may be so loosely grasped that it slips.

As the experimental and practical evidence was accumulated it was found necessary to establish some standards against which our results should be compared. After careful consideration and analysis of the problem, the following four factors were used as a basis upon which to evaluate the results.

1. *The Mechanical Efficiency Factor.* The instrument must be light and strong, as small as possible, simple in construction, neat, and with a regulating pressure device for holding the clamp (Fig. 1).

2. *The Physiological Factor.* The application of the clamp, or device, must reduce to a minimum the interference with the blood supply, the lymphatics, the nerves, and the intrinsic nerve plexuses of Auerbach and Meissner.

\* From the Third Surgical Division, St. Michael Hospital, Newark, and West Hudson Hospital, Kearny, N. J.

3. *The Surgical Adaptability Factor.* Easy hemostasis through clamp and ligatures and neat approximation of the cut

stomach is approached through a high left rectus incision. The desired folds of the stomach and jejunum are grasped with

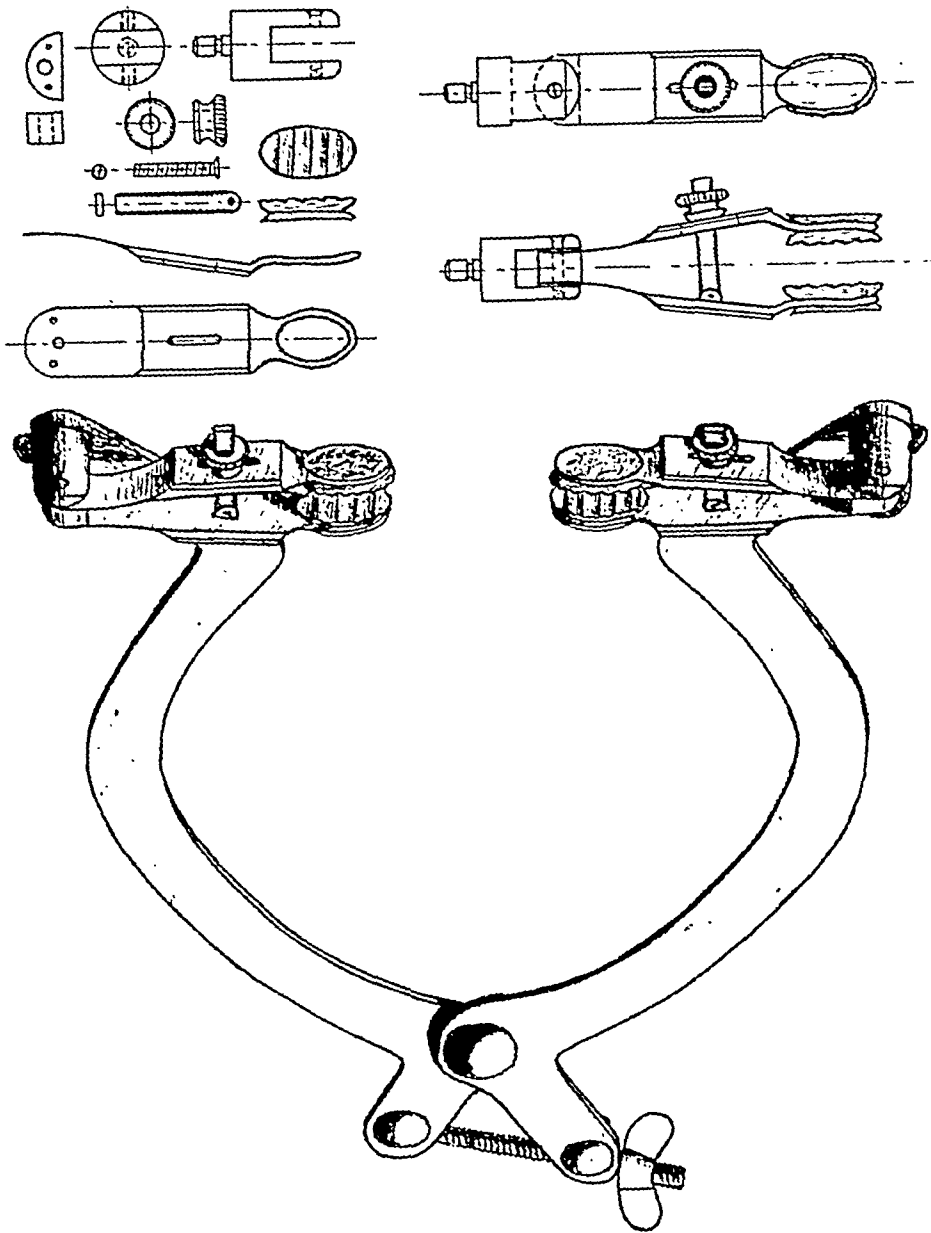


FIG. 1. Upper portion of drawing shows the details of construction of the small clamps with locking screw and rubber inserts. Lower portion shows these clamps secured in the large tension device.

surface of the bowel through careful suturing.

4. *The Bacteriological Factor.* Extra-peritonealization through the use of rubber sheeting.

The application of this instrument and technique is described in detail using the gastroenterostomy as a typical type of enteroenterostomy (Fig. 1). The abdomen is prepared in the usual manner. The

Allis tissue clamps placed about 5 inches apart. A piece of rubber dam tissue, which is approximately 12 inches wide by 18 inches long is laid over the stomach and the long edge is applied to the fold of the stomach and held by Allis clamps (Fig. 2). The same procedure is done with the jejunum. Next the special, small intestinal clamps are fastened to the edges of the future anastomosis in the following manner.

The clamp is picked up in the right hand and at the same time the two loops of the bowel, with the rubber tissue sheeting, are by turning the thumb screw with the thumb and forefinger of the right hand until the clamp is held firmly in place (Fig. 3).

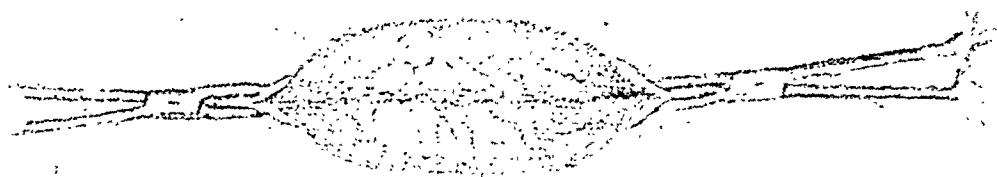


FIG. 2. This drawing shows the manner in which the rubber sheeting is applied against the sides of the bowel and temporarily held by Allis tissue clamps.

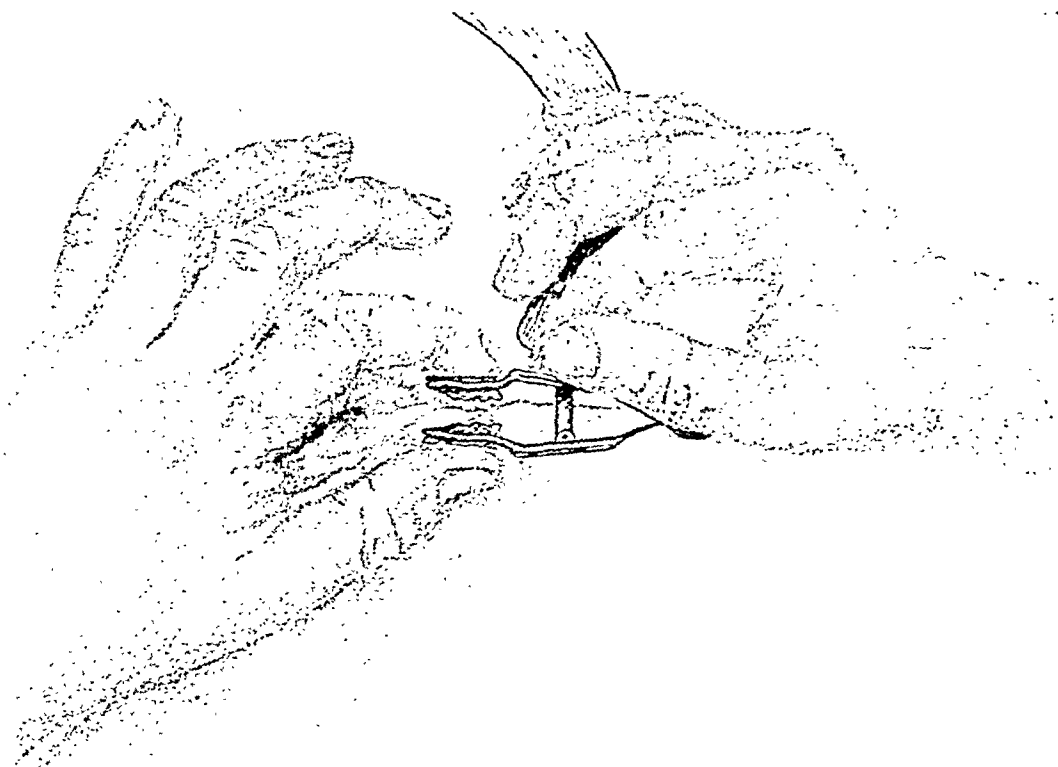


FIG. 3. The application of the small holding clamp to the loops of bowel.

picked up by the thumb and forefinger of the left hand and held firmly. The clamp is then pressed down on the bowel and held securely by the forefinger and thumb of the left hand. Pressure is then exerted

In this fashion the future anastomosis is joined together in the manner in which it will be sutured. The Allis tissue clamps are then removed. The clamps are now set in the tension device and fastened by

set screws. The proper amount of tension is exerted on the clamp by turning the thumb screw on the threaded bolt on the

Next the seromuscular stitch is applied (Fig. 5). The particular feature of this device is that it enables one to turn the

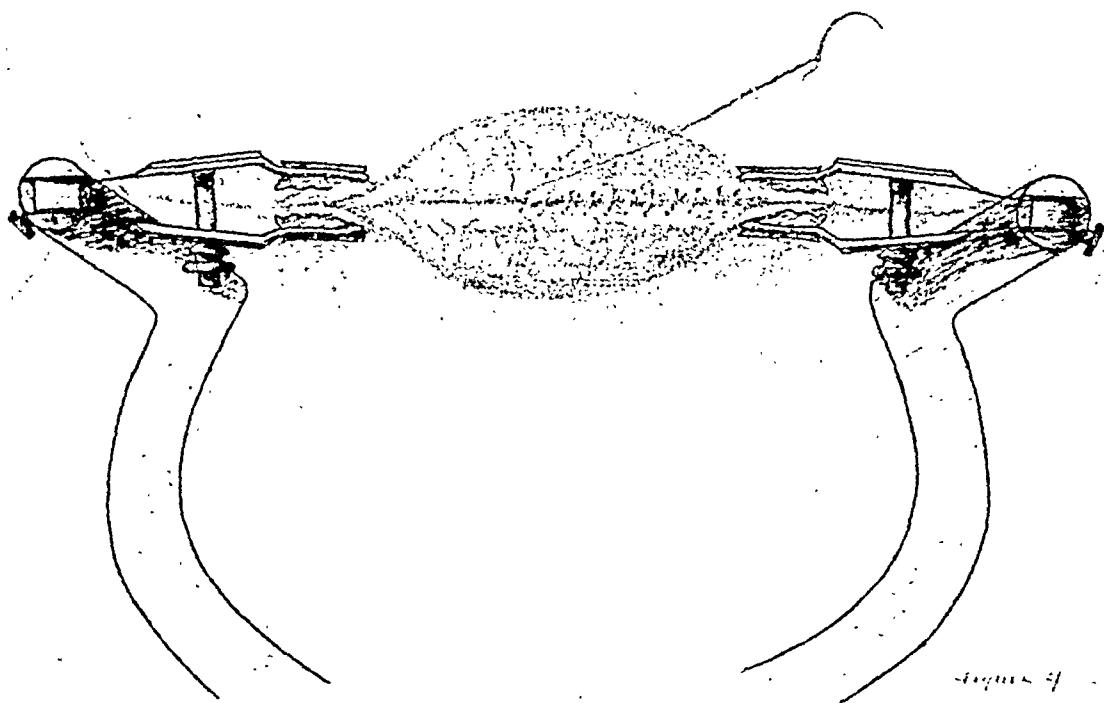


FIG. 4. The clamps are shown set in the tension device and the posterior row of peritoneal sutures being inserted.

lower part of the large tension device. In this manner the anastomosis is put under tension for easy suturing, at the same time the application of tension in the two folds of bowel smoothens out the mucous membrane within and creates a sphincter-like action. This tension limits the amount of intestinal contents that may escape upon the rubber tissue applied against the folds of the anastomosis and forms a water-tight protection against contamination of the general peritoneal cavity. The two loops of bowel are now held firmly together and the posterior continuous peritoneal suture is applied (Fig. 4). The stomach is incised along the edge of the fold directly through it and into the lumen. The active bleeding from arteries and large veins is controlled by clamp and ligature. The same procedure is repeated with the jejunum.

corners of the seromuscular layer with neatness and in a very water-tight manner, simply by releasing the large tension clamp on the anastomosis while the corner is being turned. The seromuscular stitch is completed in the usual manner and then the anterior peritoneal row of sutures is finished. This completes the anastomosis. The loops of bowel may be wiped off with a mild aqueous solution of merthiolate. The gloves are changed, the clamps are removed, and the rubber sheeting carefully lifted away. The abdomen may then be closed in layers in the usual manner without drainage. The general principles involved in anastomosing two loops of bowel together as outlined may be applied to any type of intestinal side-tracking procedure which may be desired.

In dealing with the obstructive lesions of the gastrointestinal tract due to car-



cinoma, adhesions, hernia, volvulus and intersusception is which a resection must of necessity precede the anastomosis the tubing and clamp this forceps on the proximal loop of bowel about 5 inches above the anastomosis.

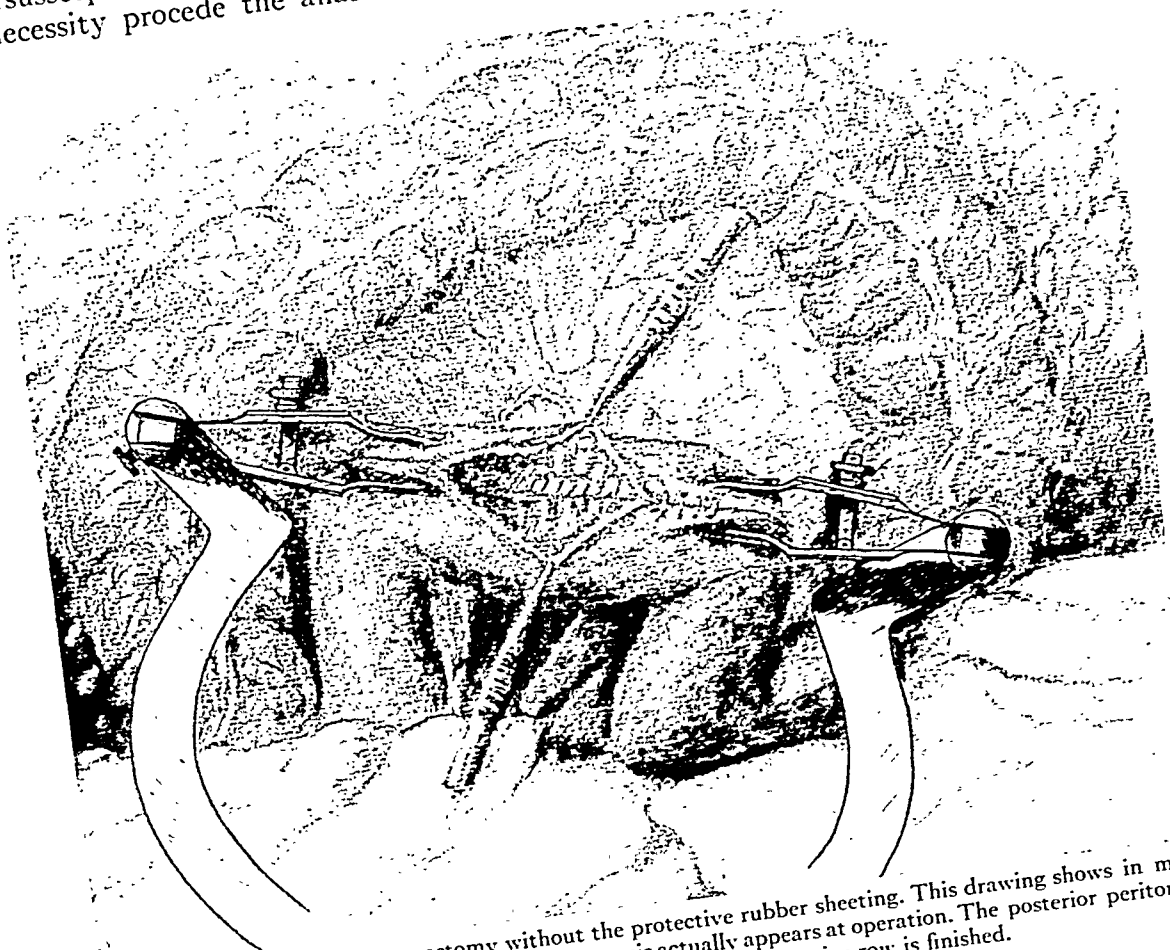


FIG. 5. A posterior gastro-enterostomy without the protective rubber sheeting. This drawing shows in more intimate detail the manner in which the anastomosis actually appears at operation. The posterior peritoneal and sero-muscular sutures have been inserted and one-half of anterior row is finished.

technique is modified in the following manner.

The segment of diseased bowel is removed in the usual manner. Before removing the clamps on the severed edges of bowel the intestinal contents are aspirated through a medium size trochar inserted into the free edge of the bowel at that point which will be approximately the middle of the anastomosis. The ends are closed over and the isomesenteric edges of the bowel are laid together and joined as described. As an alternative method to prevent the intestinal contents from escaping, we cut off the sharp points on a tonsil thumb forceps, threaded the sides with rubber

#### DISCUSSION AND CONCLUSION

The careful consideration of the text and pictures will show that this method offers a better procedure than that done with the conventional type of clamp for the following reasons:

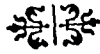
An anastomosis may be accomplished rapidly with the minimum amount of surgical shock and trauma to the patient. The control of the bleeding is taken care of primarily, thus, avoiding the danger of secondary hemorrhage. The anastomosis heals more rapidly because of the minimum amount of interference with the natural physiological functions of the intestines,

thus avoiding the dangers of secondary sloughs. Healing is promoted by first intention through accurate and firm approximation of the tissues. The general peritoneal cavity is protected from infection by a tight, elastic, waterproof membrane which prevents leakage of infected material into the general peritoneal cavity.

Due to its great flexibility an intestinal anastomosis may easily be accomplished with this instrument within the abdominal cavity itself when it is difficult or impossible to mobilize one or both loops of bowel. This advantage not only permits the surgeon a greater refinement in his tech-

nique in this trying situation but also assures the patient a greater margin of safety from the usual complications which very often follow.

It is our personal opinion that secondary marginal ulcers following gastroenterostomy are due to the failure of securing at the time of operation a firm, uniform healing of the mucous membranes to themselves without defects. We feel that refinements in the technique for this operation will lower the percentage of this annoying complication and restore the gastroenterostomy for duodenal ulcer to its proper place in intestinal surgery.



IN the diagnosis of cancer of the intestines the following points may be taken into consideration. In comparison with the subjects of malignant disease of the stomach very many of the patients are young. . . . Intestinal features are present in the majority of cases, though they were by no means suggestive in the patients who have been under our observation. Gripping, colicky pains are common, even without the signs of obstruction. With narrowing of the lumen of the gut very characteristic features occur—attacks of severe gripping pain, abdominal distention, and presence of active, sometimes visible peristalsis in the distended coils of bowel, and, if the condition persists, vomiting and all the signs of intestinal obstruction.

Osler's Lectures on the Diagnosis of Abdominal Tumors.

# HEATER FOR INTRAVENOUS SOLUTIONS

JOSEPH K. NARAT, M.D.

Attending Surgeon, St. Elizabeth Hospital

CHICAGO, ILL.

IF the temperature of a relatively large amount of fluid injected intravenously is below that of the blood, a certain amount of heat must be furnished by the

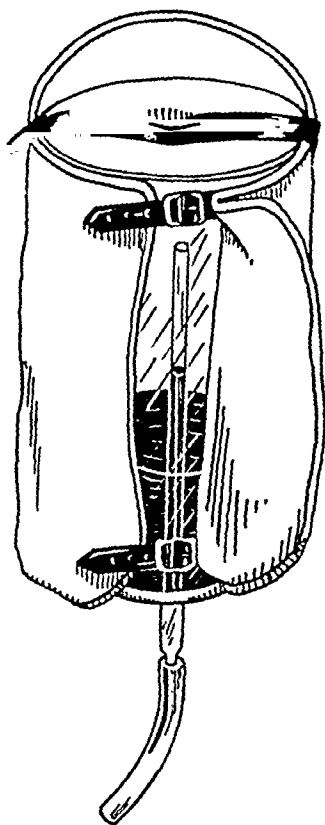


FIG. 1.—Heating pad placed around the container.

body to warm the introduced liquid. Such loss of calories may not be objectionable in certain conditions, e.g. after thyroidectomies, when the patient is "burning up," but it certainly is undesirable in the majority of conditions requiring a venoclysis, such as collapse, postoperative shock or that following injuries, etc.

Many attempts have been made to maintain the injected fluid at a constant

temperature, corresponding more or less to the temperature of the body. Hot water bottles placed around the container require refilling and their heating effect is not uniform as their shape is not adapted to the flask. Electric devices are contraindicated because a leakage is a potential danger and the wires interfere with free movements of the personnel. The flask may be placed in a larger container connected with a faucet and the temperature of the running water regulated. Such device is cumbersome and not every room is equipped with a water outlet.

It occurred to the writer that so-called chemical pads may serve as a simple expedient for this purpose. A suitable sized sac is selected so that it fits snugly around the flask, leaving sufficient space to observe the level of fluid. Two straps on the side and one over the bottom of the flask keep it in place. The sac is filled with a mixture of metal oxides or any other similar chemical compound available on the market and the addition of 20 c.c. of water produces heat of 170°F. within the sac. Repeated experiments showed that the temperature of the fluid dripping from the needle for intravenous use ranges from 92° to 100°, according to the amount of powder used. As the sac retains its temperature about ten hours, a uniform temperature of the fluid is secured. The sac can be cooled by removing it from its rubberized cloth wrapper. It can be used repeatedly as long as the life of the chemical compound lasts. The initial expense is minimal and it has been calculated that the cost of heating one liter of a solution does not exceed four cents.

# SOME AIDS IN TREATMENT OF COMPOUND FRACTURES

HERMAN CHARACHE, M.D.

Assistant Visiting Surgeon, Cumberland and Harbor Hospitals;  
Associate Radiation Therapist, Brooklyn Cancer Institute

BROOKLYN, N. Y.

THE task of cutting a window in a cast for a compound fracture is usually left to a junior interne. The opening in the cast is usually made too small and has to be trimmed with a knife or scissors, resulting in fringed edges and plaster dust sprinkled into the wound. Occasionally, after the opening has been trimmed to the proper size, the attendant surgeon finds, to his great chagrin, that the fragments of bone, or in some cases the Lane plate has been displaced during the process and the patient has to be taken to the operating room again. When the opening in the cast is made too large, the value of its support is diminished.

Should an infection occur, the opening is often found filled to the rim with pus containing particles of plaster and shreds of gauze. Although the wound is dressed

and are a continual source of reinfection, besides failing to give the proper support.

To obviate these complications, the following device is suggested:

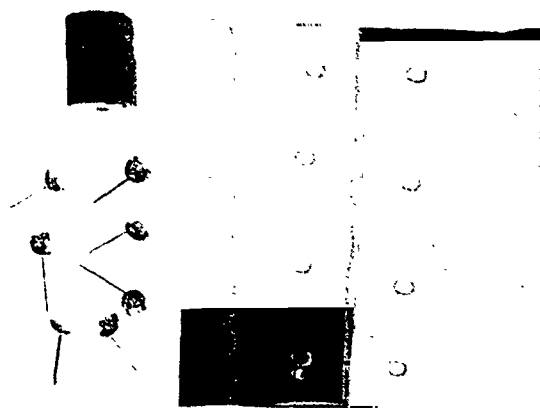


FIG. 1. Materials used.

The material used consists of four large pins with wide flat heads, the type used



FIG. 2. Showing demarcation of wound with pins and adhesive, with corset in position.

daily, or even oftener, the edges of the cast that are in direct contact with the wound become completely saturated with pus, soften to the consistency of a slough,

to pin automobile covers in place (they can be purchased for five cents), two narrow strips of adhesive, and a piece of rubber sheeting measuring about 8 by 12 inches

(Fig. 1). The latter can be purchased in the Five and Ten Cent store. Before applying the cast, the ends of

of chronic osteomyelitis and malignant bone diseases that are associated with pathological fractures and necrosis, neces-



FIG. 3. Pins protruding, showing surface markings of wound after application of cast.

FIG. 4. Showing window cut out of cast and corset laced.

the rubber sheeting are reinforced with a piece of cardboard and holes are punched through the edge in the same manner as in a postoperative corset. It is then placed behind the fractured limb. Two narrow strips of adhesive are cut to the size of the wound, a pin is put through the ends of each strip, and the adhesive is fastened along the margin of the wound (Fig. 2). The wound is then dressed, covered with the rubber sheeting which is laced with narrow tape. The cast is then applied. When the cast is completed, four pins are protruding from it, giving the surface markings of the wound (Fig. 3). When the window is cut out of the cast, the wound is ready for dressing and, if necessary, reinforcing with additional layers of gauze (Fig. 4).

These adjuncts in the application of casts are not only useful in compound fractures, but can also be applied in cases

situating immobilization by casts and daily dressings.

#### SUMMARY

1. The cutting of a window in a cast for a compound fracture often involves additional trimming when the opening is made too small, sometimes resulting in displacing the fragments of bone and contaminating the wound with plaster dust, also leaving uneven, ravelled edges.
2. When infection occurs, these edges are saturated with pus and are a continuous source of reinfection, besides weakening the cast.
3. A device is suggested where four pins indicate the exact surface markings of the fracture, and a rubber corset around the fracture aids in dressing the wound and prevents reinfection.



[From Fernellius' *Universa Medicina*, Geneva, 1679.]

# BOOKSHELF BROWSING

## SKETCH OF THE EVOLUTION OF AMERICAN ORTHOPEDIC SURGERY\*

ROYAL WHITMAN, M.D., F.A.C.S.

LONDON, ENGLAND

THE term "Orthopedic Surgery" first appeared in a book by Valentine Mott in 1841. He defined it as the combination of mechanical and operative surgery, which he predicted, was to "inaugurate a new era in the healing art."

This definition indicates clearly the remoteness of its connection in everything but name with the "Orthopédie" of Andry. For his book which bore this title, was concerned only with those defects and blemishes of childhood "which could not be concealed" and with such remedial measures as were at the command of parents and nurses.

The mechanical treatment of deformity was an old and established practice upon which operative surgery was an intrusion, and the question at issue was which was to be the dominant factor in the final amalgamation.

Those more immediately concerned in the controversy were four so-called pioneers, practicing in New York City in the latter half of the last century, James Knight, Henry G. Davis, C. Fayette Taylor and Lewis A. Sayre. The relative value of their contributions to the foundations

of orthopedic surgery and their personal influence in shaping its development may be suggested by the following quotations from their writings.

Knight's primary interest was in hernia for which he devised an effective truss. "This," he states, "served as an incentive for the construction of appliances for the restoration of impaired powers of locomotion in children, and for the treatment of deformities resulting from constitutional impairment."

To provide the proper conditions, "we introduced the initiatory efforts in our own dwelling." The experiment was so satisfactory, that within a few years he succeeded in organizing the New York Society for the Relief of the Ruptured and Crippled. A model hospital was constructed in 1870, to which he transported his patients and his family, thus assuring the domestic quality of its predecessor, in which religious and secular instruction were essential factors, as also was bodily activity regardless of the condition of the patient. "No child able to hold up his head is ever kept in bed during the day, and all able to walk by pushing a chair before them, have thus

\* Read before a joint meeting of the Philadelphia Orthopaedic Club and the Orthopaedic Section of the New York Academy of Medicine, at the Hospital for the Ruptured and Crippled, New York, November 17, 1933.

to exercise for a certain time; and those unable to walk from pain or tenderness are supplied with rolling chairs. Even the most vigorous constitution would be weakened and brought to a state of etiolation by long continued repose, and in a weak constitution the malady would be correspondingly increased."

Knight's system of treatment "by enforced hygiene, by nutritious dietary, by mechanical appliances to insure rest to an invaded joint," supplemented by tonic remedies of which mercury was an important constituent was very successful. For according to his report, "75 per cent of the ordinary conditioned patients, laboring under synovitic disease, were restored to self sustaining ability."

Knight described his practice as surgico-mechanics, which as outlined in his book "The Orthopaedia" included in its scope all disabilities that might be treated by bandaging and bracing, even uterine displacements and hemorrhoids. He was absolutely opposed to surgical intervention and would have had "conservatism engraved over the entrance of the hospital" which he had founded.

Davis practiced "conservative surgery." This was defined in the introduction of his book, published in 1867 representing the experience of thirty years, by a quotation from Hippocrates, "As a mode of cure, and it requires neither cutting nor burning, nor any complex means."

The chief purpose of the book was to exploit constant elastic traction as a potent and comprehensive remedy for joint disease and deformity, "a field so fruitful that we could wish for another term of life than that allotted to man to enable us to continue these investigations."

He established what became known as the American treatment of hip disease, by constant elastic traction, which by permitting motion without friction assured nutrition and prevented ankylosis. In cases treated by his method "healing should occur without further erosion of

the diseased surfaces and full motion will be restored."

Davis, like Knight was absolutely opposed to surgery. He "trusts that the time is not far distant, when intellectual efforts to preserve the human frame intact will be as humane and honorable, as is the devising of some new mode of mutilating it at the present time."

Taylor's primary interest was in physical culture, and for several years after his graduation in medicine he conducted a gymnasium. Failing to arrest the progressive deformity of Pott's disease by his attempts to improve the resistance of the dorsal muscles, he devised the "spinal assistant" and later other braces for the treatment of tuberculous disease of the joints. In order to demonstrate his methods, he, following Knight's example, founded the Orthopaedic Dispensary, and a ward in St. Luke's Hospital was placed at his disposal for the care of bedridden patients, but within a few years he confined his practice to his own institution. He supplemented mechanical treatment by corrective exercises, particularly by machines, of which he invented a large number.

Although Taylor "never wrote a prescription" nor a book, he was a more constant contributor to medical literature than his colleagues and on a wider range as is indicated by such titles as "Sensation and Pain, Emotional Prodigality" and the like.

Sayre, the representative of orthopedic surgery as defined by Mott, stood much higher in both the social and professional scale than the others of the group. He was a surgeon, a founder of the Bellevue Hospital Medical School and the first professor of orthopedic surgery in this country, including in his professional title, fractures, dislocations and clinical surgery. In 1876 he published a book entitled "Orthopedic Surgery and Diseases of the Joints," "in response to numerous letters from eminent men both here and abroad urging him to prepare a work setting forth his peculiar views on pathology and treatment."

The book was based on his lectures and, as contrasted with "The Orthopaedia" reads like a romance. The operation described at greatest length, supported by illustrative cases was a subperiosteal resection of the hip, which assured regeneration of the bone and restoration of function.

Sayre considered himself as proficient in mechanical as in operative surgery and devised many appliances, of which only the plaster jacket is still in use. This was a period of acrimonious controversy. The three conservatives regarded Sayre as an arrogant and mendacious exploiter of adventurous treatment and he put no restraint on his criticism of their deficiencies both individually and collectively. Knight was considered by his colleagues as a renegade because he "permitted no traction treatment" in his hospital. Davis had a comprehensive grievance and particularly against Taylor for the utilization of his inventions without due credit, "To rob a brother of his discoveries," should in his opinion be as "derogatory to a man's standing as to patent a brace," an ethical misstep which he had made apparently unwittingly. Taylor retorted "that the only impression that Davis' spinal brace made upon him was admiration for the ingenuity, which could devise a means which by no possibility could exert any mechanical purpose at all."

It is evident that the value of the work of the pioneers can be judged fairly only on the standard of their own day and as contrasted with the prevailing neglect of the deforming diseases.

From a technical standpoint the chief interest in Knight's "Orthopaedia" are the illustrations of the crude appliances which in his hands were so effective.

Davis's extravagant claims for elastic traction were rejected in his own lifetime. He insisted that traction should be applied in the line of deformity and at least this may be placed to his credit.

Taylor designed and applied his braces with a definite purpose and by raising the

standard of mechanical treatment made a lasting impression on future practice.

Sayre's "peculiar views on pathology and treatment" have not stood the test of time. His most important function was to serve as the "forerunner of American Orthopaedic Surgery." Forerunner is the proper term, for according to the "American Textbook of Surgery," published in 1892, "Orthopaedic Surgery has properly to do with deformities and contractions, especially by some form or other of mechanical appliances."

This definition might well have been accepted by a large contingent of the Charter Members of the American Orthopaedic Association, for only 8 per cent of the papers published in the annual reports for the first ten years of its existence were on operative treatment; in numbers, actually less than are contained in a single issue of the Journal of Bone and Joint Surgery.

The most militant member of the conservative group was Newton M. Shaffer, a pupil of Knight and the successor of Taylor at the Orthopaedic Hospital, an organizer and second president of the Association. He presented at the Tenth International Congress at Vienna in 1890, his own definition of the scope of orthopedic surgery, which he evidently regarded as a compromise between the two factions. It was, in substance, that its field should be restricted to the class of cases for which specially constructed appliances were required in treatment. In such cases, surgery might be employed in a subsidiary capacity. This was evidently an involuntary and impersonal concession, for it was well known that he permitted no surgical intervention in the hospital that he controlled.

Shaffer was the last aggressive upholder of the old order, and by the end of the century the new era in the healing art, when mechanical and operative surgery should supplement one another in treatment, was at hand. It is since this time that the great advances in scope and effectiveness of orthopedic treatment have



been made, advances that must be credited in most instances directly or indirectly to surgery. Of this development, this hospital may serve as an example, for it represents a natural growth, free from academic restrictions from without, and from over-regimentation from within. Of this development I can speak from personal experience for I joined the staff in 1889, shortly after Gibney, who had served an apprenticeship of thirteen years under Knight, had succeeded him. He had then already begun the transformation of what was essentially a home for crippled children without trained nurses or expert mechanics, to what became eventually a hospital, without restriction as to age or sex, representing the most liberal interpretation of the scope of orthopedic surgery.

In the report for that year no operations were recorded as evidently they were few in number and of a minor character. In 1930, the concluding year of my active service, there were 1875 operations, and in the hernia department 1647, thus a total of 3522 operations on 3429 patients. Yet the operative cases in the orthopedic department represented barely 10 per cent of the patients under treatment. For in this hospital, the in and outdoor departments are combined in a continuous and interdependent service. Thus one may supervise his operative handiwork from beginning to end. It may be stated furthermore, that the opportunity offered for the direct inspection of the effects of disease and deformity has been a great service in the treatment of the non-operative cases.

The character of the service has greatly changed in recent years. In Knight's time "synovitic diseases of the joints" was by far the most important constituent of the practice. As late as 1910, 600 new cases of tuberculous disease, chiefly of the spine and hip, were recorded at the hospital and 35.3 per cent of the cases treated in the wards were of this character. Twenty years later, in 1930, the number had been reduced to 80 and the proportion in the wards to 2.7 per cent.

Even in this class of cases, surgical intervention, once considered only as a life-saving expedient, has proved of value as a conservative measure, as for example, the anchylosing operations on the spine to check the destructive process and progressive deformity.

In this connection it may be of interest to note that the Orthopaedic Hospital, for many years the upholder of the traction treatment of hip disease, has now become the foremost exponent of operative ankylosis as the most effective means of assuring a useful limb. Although as has been noted "hip disease" has become relatively an insignificant factor in the hospital routine, the therapeutic importance of the hip joint has been greatly increased.

The pioneers knew nothing of coxa vara, Legg-Perthes' disease, fracture of the hip in childhood or the epiphysial displacements of adolescence. These disabilities were probably classed as "Synovitic disease" and such errors in diagnosis doubtless explain the curative effects of the traction treatment.

Nor was there at this time effective treatment for the affections for which operative intervention was required, for example, for fixed distortion of the limbs, a common result of disease or injury of the joint; for congenital dislocation of the hip in its various stages; for fracture of the neck of the femur, either immediate or for non-union; nor for arthritis deformans.

Thus far only the hospital service has been considered to support the proposition that operative surgery has been the chief agent "in inaugurating Mott's New Era." Actually, the outdoor department is of far greater importance numerically and from the standpoint of the student, for in this heterogeneous collection of cases drawn from all departments of medicine may be found every type of disability illustrating what may be called the natural history of the crippling diseases.

Here one has the opportunity to identify groups of cases, unrecognized and neglected and to establish the principles of treatment

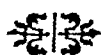
that become generally available. As an illustration, I may cite what in one of my earliest contributions to orthopedic literature I termed the weak foot to distinguish it from the obvious deformity of flat foot. The weak foot was defined as a defective posture which induced disability and progressive deformity, that might be prevented and remedied by restoring the normal relations of the foot and leg. In my first year of service I succeeded in tabulating 100 of these cases. In 1930 over 5000 new cases of this type were recorded. In the meantime, under the name of broken arch it had become the most familiar of all the minor disabilities. The construction of shoes and supports designed to protect and to sustain the arch had become an important industry and it formed the cornerstone of the flourishing school of podiatry.

Mott has been credited with the definition of orthopedic surgery as the combination of surgery and mechanics. It must be borne in mind, however, that the surgery to which he referred was the subcutaneous division of contracted tissues. This was considered a great discovery because it was fairly free from the danger of infection. Thus the new era in a larger sense was postponed for half a century or until freedom from operative infection had been practically assured.

When orthopedic surgery outgrew the restrictions that had identified it with the mechanical treatment of deformity, it lost its former qualification as a specialty and became as Sayre had maintained, a branch of surgery.

It is particularly concerned with defects and disability of the bodily mechanism, to which every department of medicine contributes. Its field is the broad and ill defined region between general surgery and general medicine. It is most closely connected with the former in a cooperative sense, by fractures and acute diseases of the bones and joints, and with the latter, by paralytic disabilities and the so-called rheumatoid diseases of the joints. This therapeutic field provides an opportunity for many practitioners qualified or otherwise. Although the orthopedic surgeon because of his familiarity with the natural history of the disabling diseases should be best qualified to direct the treatment, he rarely sees the patient until the stage of deformity.

One may conclude, therefore, that although the potential scope of orthopedic surgery is large, the most stable contingent in practice will be the class of cases for which operative and mechanical surgery are essential, for neither the technical skill nor the experience that should direct these positive methods are at general command.



# PRACTICAL CLINICAL GYNECOLOGY

HENRY C. FALK, M.D., F.A.C.S.

## THIRD INSTALLMENT

### CONTENTS

#### [ *This Issue* ]

| CHAPTER              | VOL. XXXVI | PAGE |
|----------------------|------------|------|
| v. Fibroids. . . . . |            | 559  |

#### [ *Previously Issued* ]

|   | VOL. XXXV | PAGE |
|---|-----------|------|
| i. Examination of the Patient . . . . .   |           | 153  |
| ii. Preoperative Hospital Routine; Preparation of the Patient; Post-operative Hospital Routine. . . . . |           | 172  |
| iii. Abortion. . . . .  |           | 187  |
| iv. Gonorrheal Infection of the Tubes. . . . .  |           | 629  |

## CHAPTER V

### FIBROIDS

In discussing the question of fibroids it must first be understood that the terms "fibroids," "fibromyomata," "myomata" and "fibromata" are all synonymous. An absolutely pure fibroma or myoma is rare, as a rule, one or the other tissue will predominate.

#### ETIOLOGY OF FIBROIDS

Heredity plays a very minor role in the etiology of fibroids. It seems to play a much smaller role in fibroids than it does in carcinoma. It is not unusual however, to find fibroids occurring in two or more sisters.

The theory that these tumors take origin from embryonal rests (Cohnheim-Ribbert) is frequently brought forth. Another theory advanced several years ago is based upon the idea that the uterine muscle undergoes cyclic changes similar to the endometrium. The sponsors of this theory stated that when there was an upset in the cyclic changes, such as would be produced by an over-production of the ovarian hormones, this upset would cause some change in the involution of the muscle fibers with a resulting fibroid formation.

There is apparently some relationship between sterility and the formation of fibroids. Just what this correlation is, is unknown. Fibroids seem to occur more often in sterile patients or those who have been sterile for a long time, than in patients who have borne several children.

#### ORIGIN

Little is known about the actual origin of fibroids. They apparently develop from modified muscle tissue. If several very small fibroids are examined, some one spot in the circumference of the small tumor will be found where the fibroid and the muscle capsule around it are intimately blended, as if the muscle had something to do with the origin of the fibroid itself.

All fibroids start as **interstitial** or intramural tumor masses in the musculature of the uterus and grow in one of two directions, either toward the peritoneum, to become subperitoneal

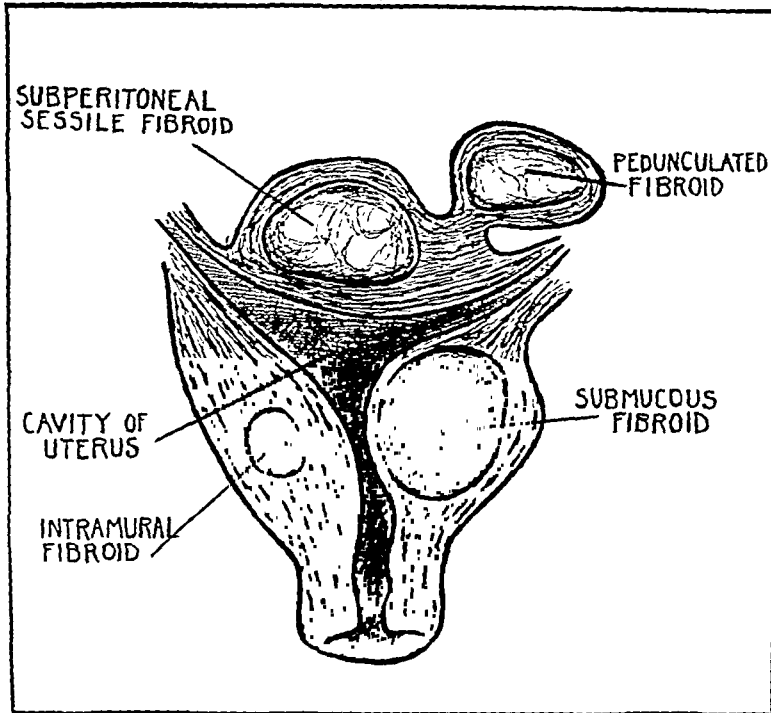


FIG. 59. Fibroids of the uterus, showing the various anatomical types.

or toward the uterine cavity to become submucous. They may be either sessile, with a very broad base or pedunculated with a rather narrow base (Fig. 59). If the tumor grows laterally between the layers of the broad ligament, it forms an intra-ligamentary fibroid. If the tumor takes origin from the cervical musculature, a cervical fibroid is formed.

#### GROSS PATHOLOGY

Single tumors may occur but as a rule they are multiple. They may be very small or very large. The largest fibroid reported in the literature weighed approximately ninety pounds.

Fibroids are always well circumscribed and do not infiltrate the tissue. They are firm to the touch, and, on section, the

muscle tissue retracts; this causes the fibroid, which is very dense and hard to project beyond the musculature. The cut section of the tumor is white, hard and firm to the touch and the strands or bands can be seen running in all directions. These strands are white and very glistening in character.

Frequently the question arises in a pedunculated submucous tumor mass, as to whether it is a polyp or a fibroid. As all submucous fibroids start intramurally and grow towards the endometrium, a layer of muscle tissue will always be found over the surface of the fibroid and immediately under the endometrium. This layer of muscle tissue may be very scant but it is there nevertheless, even though it may require a microscopic section to demonstrate its presence.

The blood vessels ramify the surface of the fibroids. There are very few blood vessels in the center of the tumor mass proper. The arteries are usually very small; the veins are quite large and are apparently out of all proportion to the arteries both as to the size and number.

### HISTOLOGY

This is quite uniform. It consists of bundles of nonstriped muscle and fibrous tissue, running in bands or whorls. When the fibres are cut lengthwise, they show long spindle-shaped cells, in bundles and in whorl-like arrangement. If the fibres are cut transversely to the long axis, the cells present themselves as small spheroidal masses of protoplasm with round central nuclei. Mitotic figures are very rarely seen in fibroids. That is important particularly in differentiating a cellular fibroma from one which has undergone sarcomatous change.

Owing to the lack of blood supply in the center of fibroid tumors of any size, various types of degenerative changes take place, hyaline degeneration being the most frequent. On section the hyaline degeneration shows itself grossly as whitish-yellow areas, sharply demarcated from the surrounding tissues. When blood pigments are present due to injury, all varieties of colors from yellow to grayish blue, to red, to brown and to reddish blue may be seen.

Should there be any interference with the venous return from the fibroids, the tumors become edematous and quite soft. An edematous fibroid on section is very moist. Occasionally the hyaline tissue disappears and spaces containing fluid develop. The wall of these spaces is composed of ragged hyaline tissue. There is no epithelial or endothelial lining to these cavities. The fluid in these cavities is either straw-colored, turbid, greenish or brownish and if infected may contain pure pus. These spaces or cavities are not true cysts but are reservoirs for broken down tissue. True cysts or dilated lymph spaces are lined by epithelium or endothelium.

It is peculiar that the closer the fibroid is to the endometrium, the less frequent are the degenerative changes. Most degenerative changes occur in fibroids that are pedunculated or parasitic. Calcium deposits are not infrequent in tumors which have undergone hyaline degeneration.

#### SARCOMATOUS CHANGES

The incidence of sarcomatous changes found in fibroids depends in a large measure on the pathologist, some finding an histological incidence as high as 25 per cent, others never finding any. The clinical incidence is less than 2 per cent.

It is difficult to decide when a fibroid has passed from the stage of a cellular fibroma to that of sarcoma. The difference is very arbitrary. What pathologist "A" may call a sarcoma, pathologist "B" may honestly call a cellular fibroma. The clinical course of the patient is usually the best guide. To find the correct histological incidence of sarcoma in fibroids, it would be necessary to examine all parts of all fibroids removed and that is practically impossible.

To recognize sarcoma on gross examination is rather important. In sarcoma, the white, coarse, fibrous whorl-like arrangement which is seen with fibroids, has been replaced by a yellow or yellowish-white homogeneous tissue. This tissue is practically devoid of fibers on gross examination and looks very much like a piece of raw pork. It is rather soft to the touch in comparison with a fibroid. Sarcomas also differ from fibroids in

that there is a marked increase in the number of blood vessels in the tumor mass. The presence of these blood vessels with the associated numerous small hemorrhages causes the tumor to

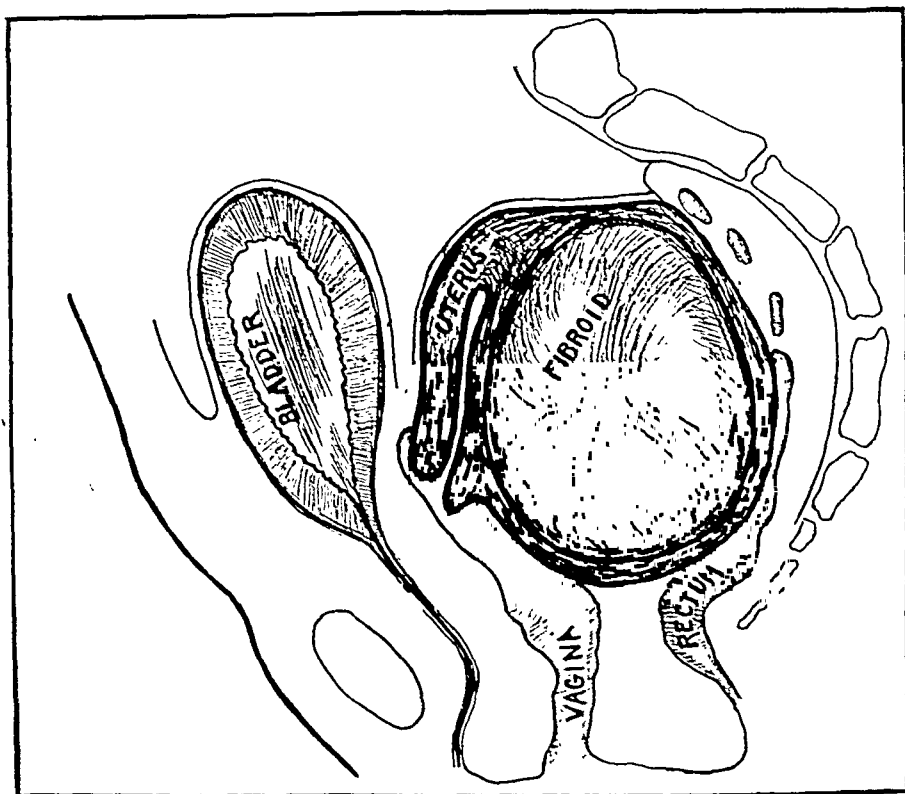


FIG. 60. Fibroid on the posterior wall of the uterus filling the cul-de-sac, the body of the uterus being forced anteriorly and upward.

have a mottled appearance, yellowish or brown in color due to the presence of blood pigment.

All tumors should be sectioned in the operating room at the time of the operation and examined grossly by the pathologist, to decide on gross examination whether or not a sarcoma is present. If a sarcoma is present a complete hysterectomy should be performed. In spite of this, the chances of cure are rather remote.

### GROSS ANATOMY

The gross anatomy depends to a large extent upon the size, position and number of fibroids. Many small fibroids may be uniformly scattered throughout the uterus causing it to be but slightly enlarged and allowing it to occupy its normal position.



Posterior wall tumors may fill the cul-de-sac and force the body of the uterus well forward (Fig. 60). Fibroids on the anterior wall may force the uterus into the cul-de-sac. The

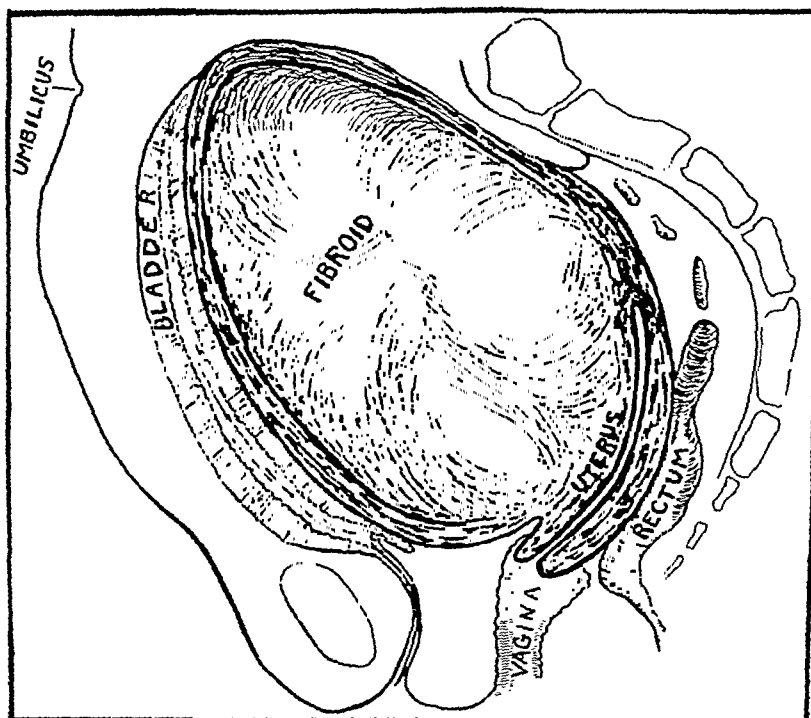


FIG. 61. Fibroid on the anterior wall of the uterus forcing the uterus into the cul-de-sac, the bladder lying on top and in front of the tumor mass.

bladder, in anterior wall tumors, may be on top or in front of the fibroid (Fig. 61) or be pushed below the tumor mass (Fig. 62). In cervical fibroids the entire lower segment may be involved and the fundus of the uterus may sit on top of the fibroid like a cap on top of the head.

The anatomical relationships of the bladder, ureters and uterine arteries are important, particularly from the surgical standpoint. The operative technique must be adapted to the modified anatomy and the gross pathology found at the time of the operation.

When a tumor mass involves the lateral wall of the uterus and extends out into the broad ligament, the uterine artery may be at any one of the four corners of the tumor mass and

should be sought in these places (Fig. 63). The ureters are always outside the capsule of the tumor and tend to remain close to the peritoneum. In enucleating intraligamentous

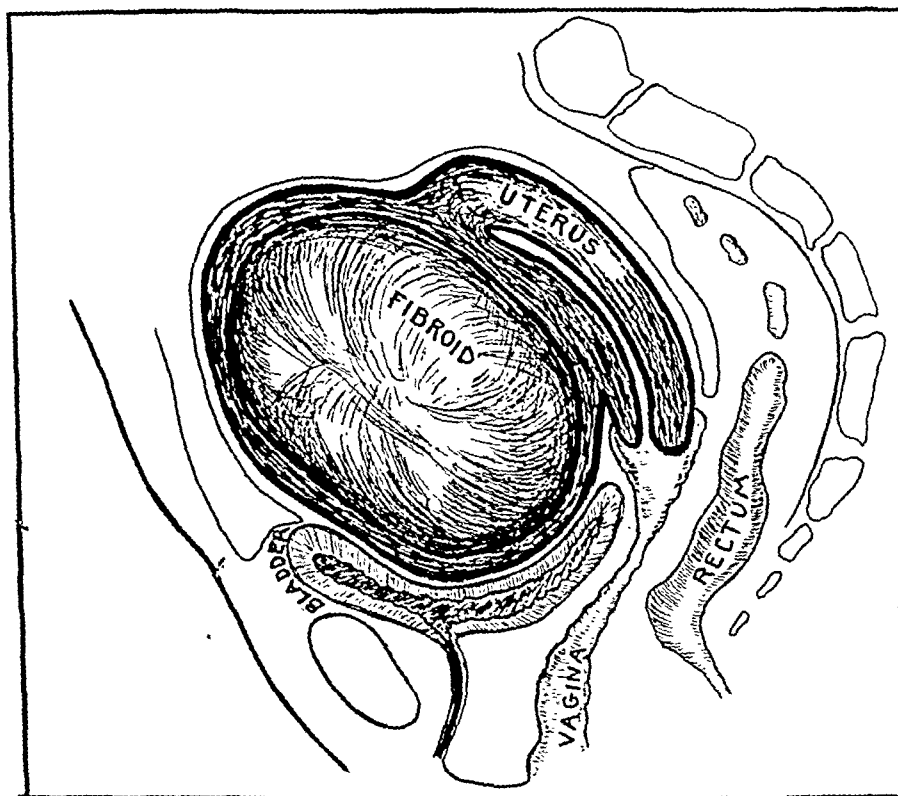


FIG. 62. Fibroid on anterior wall of the uterus with the tumor mass lying on top of the bladder.

fibroids the operator will avoid injury to the ureter if the tumor mass is removed from the inside of its capsule.

If the tumor mass projects laterally and it is closely combined with the uterus, one may find the tube and ovary on that side flattened out over the tumor; in which case the separation of the broad ligament with the insertion of the clamp through the avascular space, (step 3 in the operative procedure), may be done most easily from before backward (page 136). The round ligament passing over these large tumor masses may be markedly attenuated or hypertrophied.

The change in the relationship of the uterus and the various organs, vessels and other structures caused by the tumor growth, must constantly be kept in mind. If one will remember,

however, that fibroids begin in the musculature of the uterus and then grow outward, the various possible changes from the normal anatomy that might occur will be better understood.

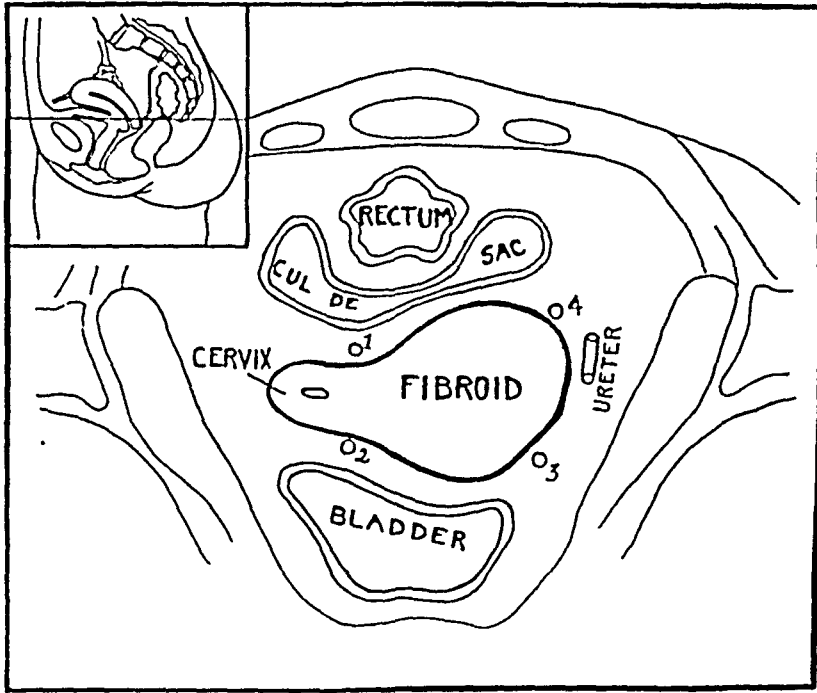


FIG. 63. Fibroid extending outward into broad ligament, showing 1-2-3-4, points to look for the possible location of the uterine artery. The ureter is always outside of the fibroid capsule. Insert shows level of transverse section.

One not infrequently finds marked dilatation of the superficial or deep lymphatics at the edge of the broad ligament, they look like elongated tortuous cysts. These might be quite confusing if not recognized as dilated lymph spaces.

#### PEDUNCULATED TUMORS

If it is accepted that fibroid tumors begin as intramural structures, how do these tumors become pedunculated? How do parasitic tumors develop?

All fibroids, as was stated, originate as interstitial tumors. The musculature of the uterus is constantly attempting to express these tumors. They may be pushed toward the peri-

toneal surface until finally they are pushed out of the uterine muscle and are attached to the uterus by a pedicle of peritoneum, varying amounts of musculature and blood vessels. This pedicle may become markedly attenuated, depending upon its length, and there may be one or more twists in it, thus interfering with the blood supply to the tumor and causing hyaline degeneration in the tumor mass.

The interference with the blood supply may cause necrosis to take place on the surface of the tumor; the omentum immediately becomes involved with the formation of an adhesion. The omentum can thus gradually take up the blood supply of the tumor mass itself until the pedicle entirely disappears (parasitic tumor). When the omentum takes up the blood supply of the tumor the vessels of the omentum become markedly dilated and there is a disappearance of the normal fat.

*Point in Surgical Technique:* As the omental vessels on parasitic fibroids are markedly dilated and as the fat in the omentum has disappeared, one should not apply clamps to the adhesions in separating them from the tumor mass, but should immediately ligate the proximal end of the vessels and put a clamp on the distal end, towards the tumor mass, cutting between. If a clamp is applied to both sides it very often tears away and much bleeding from these vessels may result.

If the musculature of the uterus forces the fibroid towards the cavity of the uterus the tumor first becomes submucous and then pedunculated. The further contractions of the uterus may then force the tumor mass through the cervix out of the uterine cavity and into the vagina.

When a pedunculated tumor from the uterine cavity is in the vagina and in constant contact with the vaginal epithelium, there may be a loss of the surface endometrium and its replacement by stratified, squamous epithelium. Tumor masses projecting into the vagina are constantly subjected to injury and infection; as a result, there is a marked round cell and polymorphonuclear leucocytic infiltration with the formation of a pyogenic membrane.

Submucous fibroids are very prone to become infected and slough. This may occur while the tumor is still submucous or it may not manifest itself until the tumor has become pedunculated and projects into the vagina. The sloughing usually begins at the most dependent part of the tumor. This sloughing mass in the cervix or vagina may cause a profuse discharge with a very offensive odor and may be mistaken for a carcinoma of the uterus or cervix.

### SYMPTOMS

*A. Age Incidence.* Fibroids may occur at any age during the active sex life of an individual. Most fibroids occur after the age of twenty years.

*B. Change in Contour of the Abdomen.* This depends upon (1) the size of the tumor, (2) its location, and (3) the adiposity of the individual.

If the tumor is lodged mainly in the pelvis, there will be no change in the abdominal contour even with fairly large tumor masses. If the tumor lifts itself out of the pelvis and the patient is obese, it may not be evident, but if the patient is thin, the change in contour of the abdomen may be quite noticeable.

*C. Caput Medusa.* Fibroid tumors rarely cause sufficient pressure on the abdominal vessels to interfere with the circulation. Therefore, one practically never sees a caput medusa (dilated abdominal veins) in these cases.

*D. Menstrual Symptoms.* No matter how large the fibroid, if there is no impingement upon the cavity of the uterus there is practically no alteration in the menstrual cycle. When the fibroid encroaches on the endometrium it puts the latter under tension. It is presumed that the large veins on the surface of the fibroid, with their congestion at the time of menstruation, cause the excessive bleeding. In other words, *a fibroid causes increased legal bleeding*, that is, more than normal bleeding at the regular time. When illegal bleeding, e.g., bleeding at irregular times, occurs, one must think of:

Uterine polyp,  
Diffuse adenomyomata,  
Fibrosis uteri,  
Carcinoma of the fundus,  
Submucous fibroid,  
Ovarian dysfunction.

Submucous fibroids may cause severe and sometimes alarming hemorrhage. It is not unusual in this type of fibroids for the hemoglobin to drop as low as 15 or 20 per cent. One not infrequently sees patients with fibroids who have had profuse bleeding for a long time, lose so much blood that they give the impression of the severe anemia seen in malignancies.

*E. Ascites.* This is very rare and when it does occur, is found only with pedunculated subperitoneal fibroids. The ascites is probably due to a twisting of the pedicle with an interference of the blood supply of the tumor mass. When ascites is found and globular masses are palpated in the abdomen, the probabilities are that one is dealing with an ovarian tumor, rather than fibroids. Ovarian pathology is more often responsible for ascites than fibroids.

*F. Pressure Symptoms.* These are not infrequent. Hemorrhoids may occur as a result of pressure of the fibroid masses on the hemorrhoidal veins. Constipation is not infrequent, whether this results from pressure or other causes is difficult to say. Pressure symptoms occur mainly when the fibroid is on the anterior wall of the cervix, pressing on the bladder, thus giving a feeling of weight, dysuria and frequency. These symptoms disappear at night when the patient lies down, as the pressure on the bladder is removed. It is not unusual to see a patient with a small fibroid on the anterior wall, present all sorts of indefinite pressure symptoms and as the tumor becomes larger (if it does not become incarcerated) it lifts itself out of the pelvis completely and the patient's symptoms entirely disappear. This disappearance of the symptoms does not mean, and should not be used as, an index of subsiding pathology.

Dilatation of the ureters have been found fairly frequently in patients with moderately large fibroids. These dilatations seem to be due to the pressure on the ureter by the fibroids. When the fibroids are removed the ureters return to normal in a comparatively short time. How much permanent damage to kidney function can result because of the pressure is difficult to state at this time. A study of 100 of these cases is now being undertaken at the Harlem Hospital. It is hoped that this study will answer some of these questions.

*G. Edema.* Cases where edema of the extremities is found are rare. When edema of the legs does occur, it is probably not due to the fibroid itself, but due to kidney insufficiency or a poor myocardium.

*H. Cardiac Changes.* Much has been written on the subject of cardiac changes with fibroids: brown atrophy of the heart muscle. This has not been found to be the fact in our series. Most of the cardiac symptoms that these patients present seem to be due to poor nutrition of the cardiac muscle, caused by the anemia as a result of the excessive bleeding, rather than the effect of toxic substances from the fibroid acting on the heart muscle. If there were a true connection between the fibroid and any cardiac changes, the most marked cardiac changes should occur in individuals with very large fibroids and this is not the case. Many more cases of cardiac changes are seen in patients with small submucous fibroids with frequent hemorrhages over long periods of time than in the giant fibroids filling the entire abdomen.

*I. Phlebitis, Thrombosis and Embolism.* These seem to occur more frequently as a postoperative complication in fibroids than in other types of gynecological cases. Why this should be and whether it is due to some changes in the metabolism is not known. Some men believe that as a result of the pressure of the tumor masses there is a slowing of the blood stream in the local vessels with the formation of a bland thrombus. This thrombus, not being fixed to the interior of the vessel as an infectious thrombus is, would therefore be more apt to cause an embolus.

*J. Bladder Symptoms.* Cystitis caused by the fibroid itself is very rare. The most frequent bladder symptoms the patients present are those due to encroachment of the tumor on the bladder itself, feeling of weight, urgency and frequency of urination. Acute retention of urine is not unusual. This is usually due to an incarcerated tumor mass pressing against the lowermost portion of the bladder and the urethra and producing an inability on the part of the patient to void.

*K. Vaginal Symptoms.* Very few changes take place in the vagina as a result of fibroids. Occasionally it may become markedly elongated as a result of stretching over a fibroid mass or it may be drawn upward as a result of a fundal tumor. Low fibroids between the layers of the broad ligament may deform the vagina by indentation. When a fibroid is delivered through the cervix into the vagina the latter dilates to accommodate the tumor mass, no matter how large it is. One may find a vagina filled by a tumor mass as large as a child's head presenting itself at a small nulliparous or virginal outlet. In degenerating submucous fibroids or polyps there may be a foul, bloody vaginal discharge resembling that found in carcinoma of the cervix or body of the uterus.

*L. Cervical Symptoms.* Many changes can take place in the cervix as a result of fibroids. It can be pushed in any direction—forward, over the symphysis, backward into the hollow of the sacrum, laterally and upward so as to be completely out of reach, or downward so as to present itself at the outlet. The cervix may become so attenuated and stretched over a tumor mass as to be unrecognizable. Its extent may be so obscured that in attempting to do a supracervical hysterectomy the upper part of the vagina is cut across instead of the cervix.\*

When a submucous fibroid is delivered through the cervix the latter can and will dilate itself sufficiently for its passage. These dilatations, however, disappear immediately after the

\*This is one of the reasons for sterilizing the vagina preparatory to all gynecological laparotomies (p. 24). Occasionally in cervical fibroids the cervix may become flattened out over the tumor mass so as to be flush with the vault of the vagina.



tumor is removed. Occasionally during the course of the operation for the removal of these tumors, the cervix will "shut down" under vision.

### FACTORS INFLUENCING OPERABILITY

Suppuration of a fibroid is rare in the interstitial or subperitoneal type of tumor. It may be found as a complication of a postpartum or postabortal infection, as a result of direct or lymphatic extension. In the subperitoneal pedunculated type, the fibroid may become adherent to the bowel and take its blood supply from the intestines. In such cases an infection of the tumor may occur as a result of direct extension from the intestine.

Hyaline degeneration due to poor blood supply frequently precedes infection. This degeneration, particularly where the myoma has broken down and becomes soft, may grossly simulate suppuration. A smear, however, will demonstrate the absence of polymorphonuclear leucocytes.

When a myoma becomes infected from a pus tube, the infection usually starts and remains on the surface of the tumor. A myoma rarely becomes infected from its center outward.

Pus tubes or an infected myoma should be considered in a patient presenting an apparently uncomplicated fibroid yet associated with a high leucocyte count.

Ectopic pregnancy as a preoperative complication does occur. Kelly reported 6 in 1000 fibroids. In our series of 500 fibroids it was found twice, on both occasions the ectopic was not diagnosed but was an accidental finding.

Carcinoma as a preoperative complication can occur. If one will remember that fibroids form more than one-sixth of all gynecological pathological conditions seen and that carcinoma of the uterus is not rare, a coincidental occurrence of the two conditions should not be infrequent. There is no definite relationship, etiological or otherwise, between the two conditions.

The differential diagnosis between a foul, sloughing submucous myoma and carcinoma of the fundus is almost impossible without a curettage and a histological examination of the curettings.

### THE DIFFERENTIAL DIAGNOSIS OF FIBROIDS

The most important single condition to differentiate from fibroids is pregnancy. *No patient in whom there is any question of pregnancy should be operated upon unless an A-Z test has been done.*

| PREGNANCY            | MYOMA                                       |
|----------------------|---|
| Amenorrhea           | Metrorrhagia                                |
| Colostrum in breasts | Breasts negative, possible yellow secretion |
| A-Z positive         | A-Z negative                                |
| Smooth mass          | Irregular nodular mass                      |
| Soft mass            | Hard mass                                   |
| Cervix soft, blue.   | Cervix hard, pink.                          |

Occasionally there has been nothing in the history to suggest a pregnancy and on opening the abdomen one is confronted with the differential diagnosis between a pregnant uterus and a soft myoma. The uterus in pregnancy is bluish and in fibroids it is usually pink. The most important differential point in diagnosis is the relationship between the round ligaments, the tubes, the ovaries and the mass. In a pregnant uterus the relationship of the round ligament, tubes and uterus to the fundus remains the same, no matter how large that uterus becomes (Figs. 64 and 65). In a fibroid, however, these structures assume an eccentric relationship to the tumor mass. If the differentiation between the two conditions is still difficult or impossible one may resort to aspiration of the tumor mass. If a pregnancy is present amniotic fluid will be withdrawn and the differential diagnosis made with no injury to the pregnancy.

A peculiar and yet not infrequent error in diagnosis is caused by an old ectopic pregnancy. An unruptured tubal

pregnancy, a tubal abortion, with hemorrhage and marked omental adhesions, has been mistaken for a fibroid. When a patient gives a history of a period of amenorrhea or some

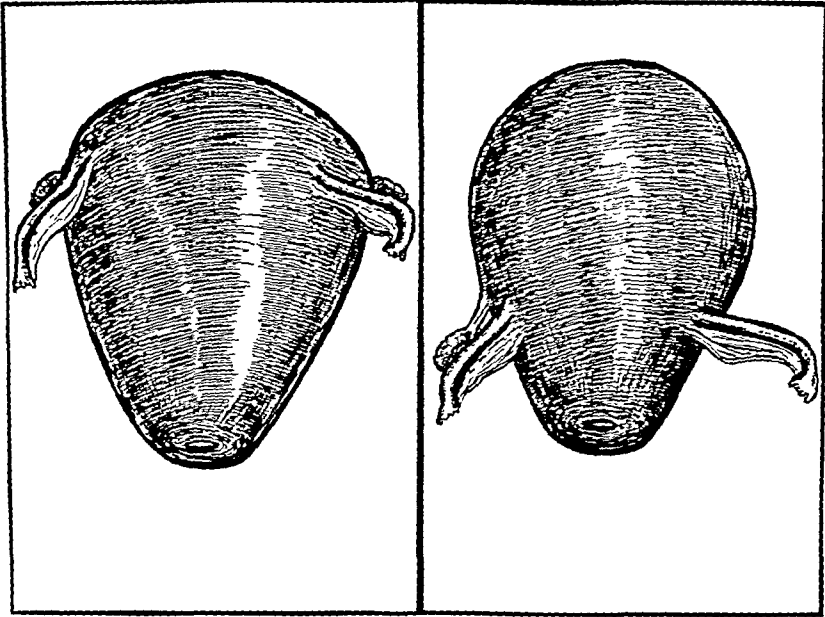


FIG. 64. Normal relationship of round ligaments and tubes seen in a pregnant uterus.

FIG. 65. Eccentric arrangement of tubes and round ligaments when a fibroid is present in the fundus.

irregularity in the menstrual cycle, always think of the possibility of an ectopic, even if a large tumor mass occupies the pelvis.

The differentiation between a fibroid and a solid tumor of the ovary is frequently very difficult as they both may have a pedicle, but as a rule the ovarian pedicle is longer. An ovarian tumor can almost always be displaced upward entirely away from the uterus, but a fibroid is usually attached more closely to the uterus and cannot be displaced. Ascites is more common with ovarian tumors. Ovarian cysts are not so difficult to differentiate from fibroids because they have a different feel, a cystic feel.

When a patient, who has had a previous gynecological operation, presents herself complaining of profuse or irregular

bleeding and an irregular mass is palpable in the pelvis, one should be careful about calling this mass a fibroid; because postoperative adhesions frequently gives one the impression of an enlarged uterus, whereas a cystic ovary or ovarian dysfunction may cause the excessive vaginal bleeding.

### SURGICAL MANAGEMENT OF FIBROIDS

The fact of primary importance with regard to the surgical management of fibroids that must be constantly remembered is, that, **every woman who has fibroids does not necessarily have to be operated upon.**

Fibroid tumors which (1) are producing symptoms, (2) are rapidly growing and (3) are causing mental distress to the patient, should be operated upon.

Submucous fibroids almost invariably cause excessive vaginal bleeding. They are very prone to infection. Due to their position in the uterus they are frequently expressed into the cavity of the uterus or vagina and become infected. They must practically always be operated upon.

Subserous fibroids cause very few or no symptoms. Infection in subserous fibroids are infrequent. They do not cause excessive bleeding. Therefore the presence of subserous fibroids is not necessarily an indication for operation.

When a patient presents herself with fibroids and the indications for surgery are present the question arises: what type of operation shall be performed? The operations of choice are: (1) myomectomy and (2) hysterectomy.

What are the advantages of myomectomy?

1. It preserves menstruation.
2. The possibility of pregnancy is still present in women who are within the childbearing age.
3. It prevents the symptoms of an artificial menopause.
4. The advantage to a young, unmarried woman from the psychic angle is untold. She continues to menstruate, she can get married as she has a uterus and therefore retains the possibility of becoming pregnant.

What are the disadvantages of myomectomy?

1. It may not relieve the symptoms for which the patient has come to operation. A large number of fibroids may be removed and yet a small pedunculated or submucous fibroid which could not be felt and therefore was not removed, may continue to cause the same symptoms for which the patient sought relief.

2. There is always a possibility of a recurrence of the fibroids.

3. The postoperative morbidity in cases of myomectomy is greater than the postoperative morbidity in hysterectomy.

4. Myomectomy is usually more difficult technically, than supracervical hysterectomy.

5. Owing to the technical difficulties and the marked increase in hemorrhage, myomectomy is much more hazardous in frail, anemic women. In women whose hemoglobin is as low as 20 to 25 per cent, even though they receive a preoperative and postoperative transfusion, the hemorrhage associated with the myomectomy may be enough to push such a patient over the danger line; whereas a hysterectomy, in the same patient, could be practically bloodless and therefore less hazardous.

In comparing a large series of cases where myomectomy or hysterectomy were performed, it was shown that only 75 per cent of the cases were cured by myomectomy, whereas 97 per cent were cured by hysterectomy.

#### FACTORS INFLUENCING THE TYPE OF OPERATION CHOSEN

Myomectomy can be performed on subperitoneal, pedunculated, interstitial fibroids and occasionally in submucous fibroids. In the latter, there is always the danger of opening the cavity of the uterus. As a rule the cavity of the uterus is sterile. If however, a submucous or pedunculated fibroid is presenting itself at the internal os or in the cervix, it may have become infected, thereby infecting the cavity of the uterus. One must therefore always exercise special care not to enter the cavity of the uterus in the removal of the submucous fibroids. If there is

any possibility of entering the cavity of the uterus, proper preoperative preparation and sterilization of the cavity should be done. This will reduce the dangers of infection to a minimum. Preoperatively the uterine cavity should be sterilized with either iodine or mercurochrome from below, in the anesthesia room. If at any time during the operation the surgeon enters the uterine cavity, iodine on an applicator or iodine soaked packing should be inserted into the uterine cavity. The opening in the cavity should be immediately closed and the instruments, which were used should be discarded as dirty. If there is any question in the operator's mind as to the sterility of the field, it should be changed, including the gloves.

*"You are dirty, if there is any doubt in your mind as to whether you are clean."*

If there are fibroids present in the uterus and a necrotic submucous fibroid is presenting itself in the cervix or vagina, a vaginal myomectomy must first be performed. The hysterectomy should not be done until the patient has had two normal menstrual periods. If an abdominal hysterectomy is done too soon after a vaginal myomectomy, the patient may develop a peritonitis from the infected endometrium, causing a fatality. Endometritis is a self-limited disease and, as a rule, disappears after one menstrual period. Chronic endometritis is rare. Nature tends to clear up any infection in the uterine cavity very rapidly if allowed the necessary time.

In myomas of the broad ligament, intraligamentous fibroids, subvesical fibroids and cervical fibroids a hysterectomy is the procedure of choice. The young operator may encounter considerable difficulty in attempting myomectomy in these cases. Only after he has had considerable experience in gynecological surgery should he attempt a myomectomy in cases of intraligamentous and cervical fibroids.

*Dangers in operating on myomas of the broad ligament (intraligamentous and cervical fibroids):* (1) injury to the ureter, (2) injury to the bladder and (3) oozing between the layers of the broad ligament with the development of a hematoma causing late morbidity with the possible development of

an intraligamentous abscess. All these complications must be carefully weighed before attempting to do a myomectomy on any one of these types of cases.

Never operate on a fibroid uterus unless the patient has given consent to do whatever surgical procedure may be found necessary or feasible. If the patient insists on a myomectomy, tell her that everything possible to save the uterus will be done, but if, during the operation, a hysterectomy is necessary to save the patient's life, consent must be granted.

Myomectomies cannot be done on cases of diffuse adenomyomas (of Cullen) of the uterus. Myomectomy is also totally unsuited for fibroids that are infected. The presence or absence of infection in fibroids can be judged by the leucocyte count and the sedimentation time. These are not absolute, as there may be other pelvic infection present. If a simple fibroid presents a leucocytosis or rapid sedimentation time, in all probabilities it is infected or complicated by pus tubes.

If a fibroid is complicated by a carcinoma of the cervix, that fibroid had best be treated with x-ray or radium. If they are not available radical surgery can be performed. If a fibroid is complicated by carcinoma of the body of the uterus, radical surgery should always be done.

Why this difference between carcinoma of the body of the uterus and carcinoma of the cervix?

Carcinomas of the cervix are practically all infected with streptococci. If treated with x-ray and radium the cervical lesion as a rule heals. After the infected cervix has healed, radical surgery can be carried out if necessary with a minimal risk of infection to the patient.

When carcinoma of the body of the uterus complicates a fibroid, as a rule, the diagnosis is not made preoperatively. The diagnosis can be made if a curettage were done before the radical surgical procedure was performed. When the diagnosis is made, vaginal hysterectomy or total abdominal hysterectomy can be done with little risk of infection to the patient.

When a hysterectomy is decided upon, the supracervical type of operation is the procedure of choice. The mortality of

total hysterectomy is greater than that of the supracervical operation. The argument that carcinoma may occur in the retained cervix does not seem to be of sufficient importance to warrant the total operation. The primary mortality of radical hysterectomy is definitely greater than the incidence of carcinoma in the retained cervical stumps. These are, not alone our statistics, but those of other clinics as well. The incidence of carcinoma of the cervix is definitely low. If the cervix is badly lacerated or eroded, it should be treated before the hysterectomy is undertaken. A large percentage of cervical lesions, excluding carcinoma, can be cleared up and made practically innocuous with office treatment. When the cervical lesion has been cured a supracervical hysterectomy can be performed.

### RADIATION THERAPY

Fibroid tumors of the uterus can be treated by x-ray and radium. There are however, certain facts which must be thoroughly understood before advocating this procedure.

1. Radiation therapy primarily attacks the ovaries and secondarily the tumor masses; so that when it is used in young women under forty years, it abolishes ovarian function and produces distressing menopausal symptoms.

2. After the establishment of the amenorrhea the tumors shrink in size and in about 40 per cent of the cases the tumors disappear. In most patients with fibroids the tumors shrink for about one year and then remain stationary.

3. If the patient's symptoms recur or if radiation therapy is not curative it does not preclude surgery.

*Indications.* A fibroid which

1. Causes excessive bleeding,
2. Is intramural,
3. Is not degenerating,
4. Is not causing pressure symptoms, and
5. Is not complicated by other pelvic pathology, especially infections:

*in a woman over forty years of age may be treated with x-ray and radium.*



Radiation therapy in a woman under forty years is indicated only when she is a poor surgical risk due to some co-existing disease, e.g., cardiac, renal, etc.

*Contraindications.* A fibroid which

1. Is larger than a three months pregnant uterus,
  2. Is submucous, pedunculated or polypoid,
  3. Is undergoing some form of degeneration or becoming calcified,
  4. Cannot be accurately diagnosed, especially the differential between fibroid and ovarian tumors,
  5. Is causing pressure symptoms either by its presence or location,
  6. Is rapidly growing and soft and may have sarcomatous change, and
  7. Has been previously operated upon and may therefore have intestinal adhesions (radiation therapy might cause severe intestinal complications):
- should not be treated with x-ray or radium.*

#### PREPARATION OF THE PATIENT FOR OPERATION

All fibroid cases should have the following laboratory data preoperatively:

1. Complete blood count.
2. Complete urine.
3. Wassermann or Kahn test.
4. Sedimentation time.
5. Phenolsulphonephthalein test of kidney function.
6. Mosenthal test for kidney function.
7. Blood chemistry, if indicated. If laboratory facilities allow, blood chemistry should be done routinely.
8. Two or three blood pressure readings.

#### PREPARATION OF THE PATIENT

All patients coming to the operating room should be prepared for a dilatation and curettage and laparotomy, all pubic and abdominal hair should be removed. In the anesthesia room after anesthesia has been induced, the patient should be placed in the lithotomy position, painted or sprayed with mercurochrome (Scott's solution) and catheterized. At catheterization, urine must always be obtained, thereby insuring the fact that the catheter has been in the bladder. There is no single factor which tends to make a hysterectomy more difficult than a full bladder. Following catheterization the patient should be

examined under narcosis and an exact pathological diagnosis made. Following the examination, the vagina is thoroughly painted or sprayed with mercurochrome, the cervix is painted and if there is any possibility of entering the uterine cavity, a cannula is introduced into the cervical canal and without pressure mercurochrome or iodine solution is injected into the uterine cavity. The patient is then placed in the dorsal position and brought into the operation room.

### TECHNIQUE OF MYOMECTOMY

Step 1. The abdomen is opened with the usual paramedian incision (page 90).

Step 2. The pelvis is thoroughly walled off, using the three pad technique (Fig. 47).

Step 3. Isolate the factors. Always carefully and completely isolate all the factors before any actual cutting or operating is begun. *If the preliminary isolation of all the factors is carried out, most surgical procedures become comparatively simple.*

Step 4. After all factors are isolated, the uterus must be carefully palpated so as to identify the number and location of the various tumors. If the number and location of all the tumors is not known some of the sutured area may be reopened by mistake as sutured uterine muscle following myomectomy feels like tumor masses.

Step 5. Remove all pedunculated fibroids first with a simple circular or elliptical incision around the base of the pedicle and a figure of "8" stitch (Fig. 66).

To remove a sessile, interstitial or intramural fibroid, an incision is made as far forward on the anterior uterine wall as possible, so as to reduce the possibility of intestinal adhesions to a minimum. It is made over the most prominent part of the tumor, going through the muscle, down to the capsule of the tumor. *Make the incision ample. Always remember that the patient has two tubes and that there is a cavity of the uterus.* When the fibroid is reached it can usually be recognized by the difference in color as compared to the uterine muscle. When the capsule of the tumor is exposed, two or three large

vessels are usually cut and bleed freely. Do not grasp these bleeders with small artery clamps, they won't hold but use small Kocher clamps.

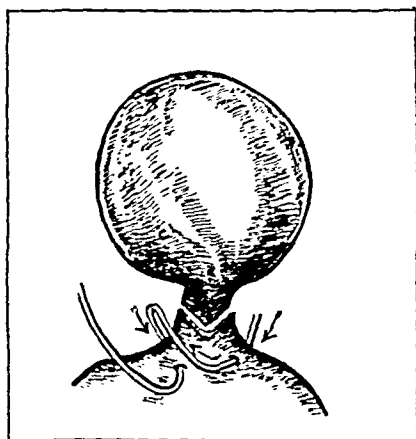


FIG. 66. Pedunculated fibroids removed with an elliptical incision and a figure of "8" stitch.

Once the tumor is exposed it can be placed under tension by the hand, under the tumor, pressing it into the uterine wound, or it can be grasped with a tenaculum and drawn into the wound. With a curved scissors, sticking close to the capsule of the tumor and following definite lines of cleavage, using sharp and blunt dissection, the tumor is removed. While the tumor is still attached to the lowest part of the cavity, which is well exposed, the inside of the cavity is grasped with Allis clamps so as to completely evert it. This greatly aids the closure of the cavity and the prevention of dead spaces. The cavity is closed with interrupted plain catgut sutures placed in tiers using a figure of "8" stitch. All dead spaces must be eliminated and all bleeding must be controlled. The superficial portion of the cavity and the peritoneal edge are closed with a stitch very similar to the stitch used in the Bell-Beuttner operation (Fig. 67).

All sutures are of No. 2 plain catgut on a medium size Mayo needle. A mattress suture may be used instead of the figure of "8." All the ragged edges should be cut away.

*Surgical Axiom:* Do not approach a second fibroid until the first one has been taken care of and the bleeding stopped.

Following the removal of all the fibroids, some form of

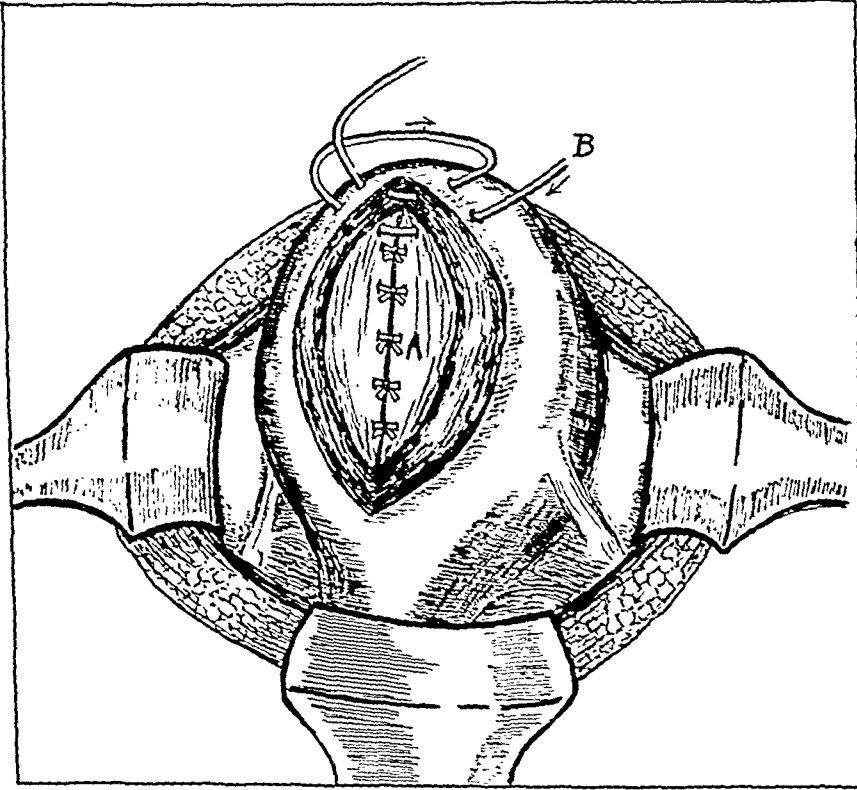


FIG. 67. Myomectomy, fibroid removed from anterior wall of uterus. A, interrupted stitches, deep, to obliterate dead spaces; B, modified Stewart stitch to close superficial layer.

suspension, suturing the posterior wall of the uterus to the abdominal wall, should be carried out.

#### TECHNICAL PROCEDURE IN HYSTERECTOMY

*Surgical Axiom:* Do not attempt to operate through too small an incision. One inch below is worth two inches above.

An ample paramedian incision is made. Cut the fascia of the rectus sheath down to the pubic bone. Insert the three abdominal pads thus isolating the operative field. In hysterectomy it is often advisable to insert a fourth laparotomy pad to completely isolate the field and also to cover the sigmoid and the cul-de-sac, so that if there is any spill, it will be on the pad and not on the peritoneum.

Identify all the factors: the round ligaments, uterus, tubes and ovaries.

In doing a hysterectomy with the clamp suture technique,

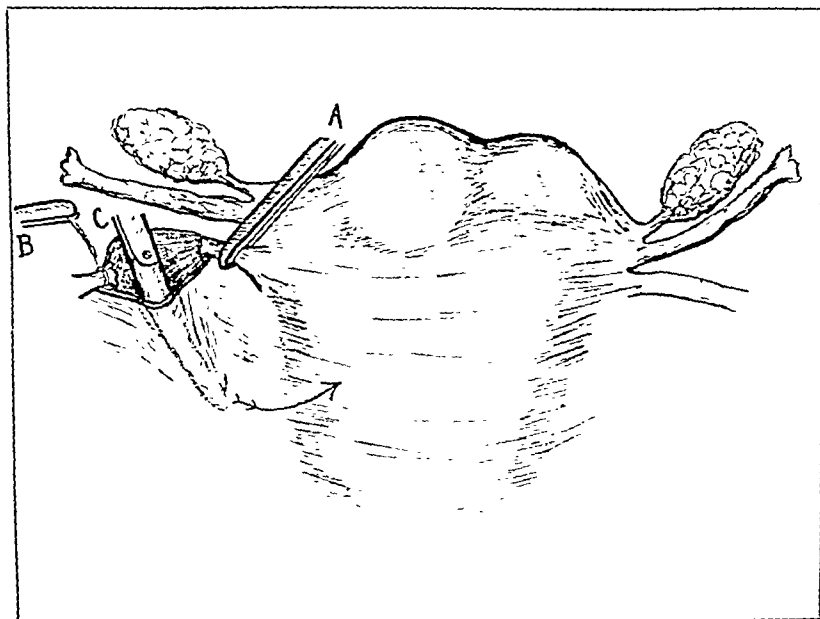


FIG. 68. Hysterectomy technique. Steps 1 and 2. A, clamp applied to uterine end of round ligament; B, Kut-Klamp applied to ligature on outer end of round ligament; C, scissors inserted under vesicouterine fold to separate it from the uterus before cutting it close to the uterus.

ten sutures are used. Sutures 1 to 6 and sutures 8 and 9 are of No. 2 plain catgut, cut in three, on a medium size Mayo needle. Suture 7 is of No. 2 plain catgut, cut in two, on a cutting needle. Suture 10 is of No. 2 plain catgut, cut in two, on a moderately small Mayo needle.

Step 1. Clamp, ligate and cut the round ligament of the uterus on the right side.

A clamp is applied to the right round ligament near the uterus (Fig. 68, A). The round ligament is lifted with a mouse-tooth forceps and suture 1 is placed in the loose avascular tissue under the round ligament and tied. The round ligament is cut and the suture is left about 4 inches long and a Kut-Klamp (Fig. 69) applied to its end. One of the most frequent

errors in technique is to place this suture too close to the uterine end of the round ligament. As a result it is difficult to find the plane of cleavage of the vesicouterine fold, which is

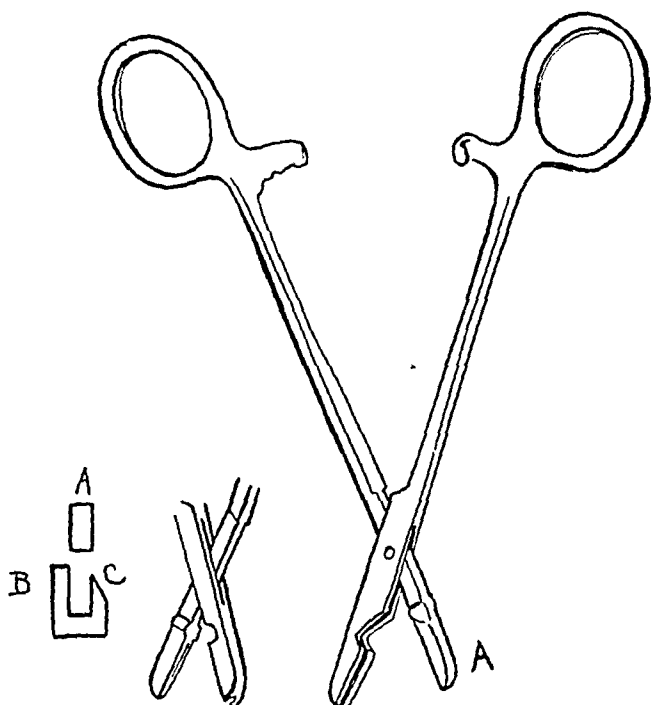


FIG. 69. Kut-Klamp; A, clamp and scissors combination. The portion of the clamp A on closing down on B acts as a clamp and holds the catgut while edge C acts as a scissors and cuts off the excess portion of the gut (*derived by Solomon*).

the next step in the procedure. This suture should be placed at a distance of 2 to 4 cm. from the uterine cornu.

Step 2. Opening the vesicouterine fold on the right side.

The uterus is drawn to the left, the first assistant grasps the suture on the cut edge of the round ligament, holding it taut and to the right, and the operator grasps the edge of the vesicouterine fold of the peritoneum with a mouse-tooth forceps at the point where it has been cut close to the round ligament and inserts a curved Mayo scissors into this space (Fig. 68, c). The point of the scissors is toward the peritoneum. The scissors are directed downward, away from and not toward the uterus. The scissors are opened (blunt dissection) and closed, the closed scissors is then brought towards the uterus and

the vesicouterine fold is cut close to the uterus, from right to left, to the midline. *Leave as much peritoneum on the vesicouterine fold as possible.* The vesicouterine fold is grasped

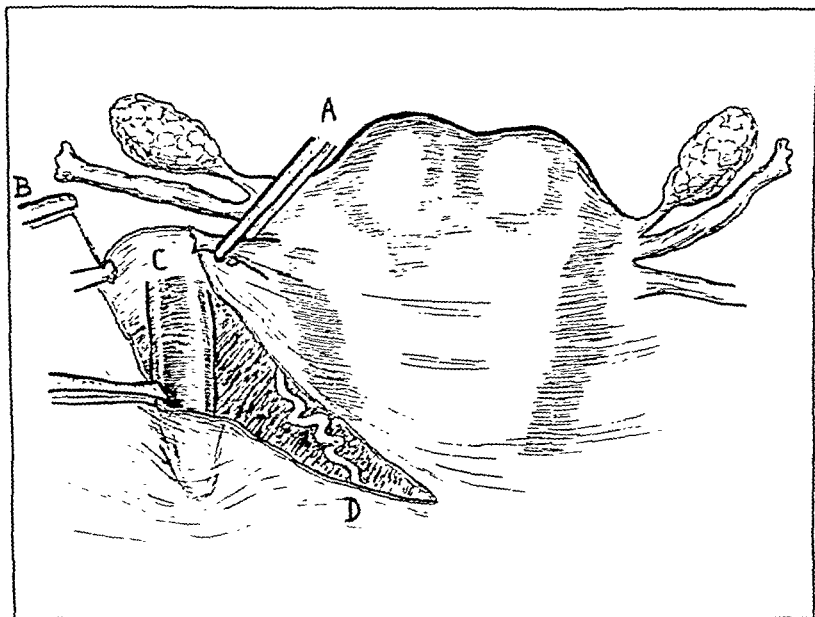


FIG. 70. A, clamp on uterine end of round ligament; B, Kut-Klamp on ligature on outer end of round ligament; C, finger introduced into vesicouterine fold to separate it by blunt dissection; D, uterine artery.

with a mouse-tooth forceps and the index finger is introduced into the space, separating the vesicouterine fold from the underlying structures from above downward (blunt dissection) and exposing the avascular space (Fig. 70).

Step 3. Opening of avascular space and ligation of broad or infundibulopelvic ligament.

The operator introduces a curved Kelly clamp, from behind forward, under the round ligament of the ovary, through the avascular space (Fig. 71, insert). The clamp is opened so as to make a large enough opening in the broad ligament for the assistant to introduce a curved Kelly clamp, from before backward, close to the uterus, one blade going through the avascular space and the other over the top of the broad ligament (Fig. 71, A, B). This clamp is closed. On inserting this clamp it may be necessary to remove the clamp on the

round ligament of the uterus (Step 1). A second clamp is introduced in the same manner from before backward by the assistant, leaving enough space between the clamps, so that the

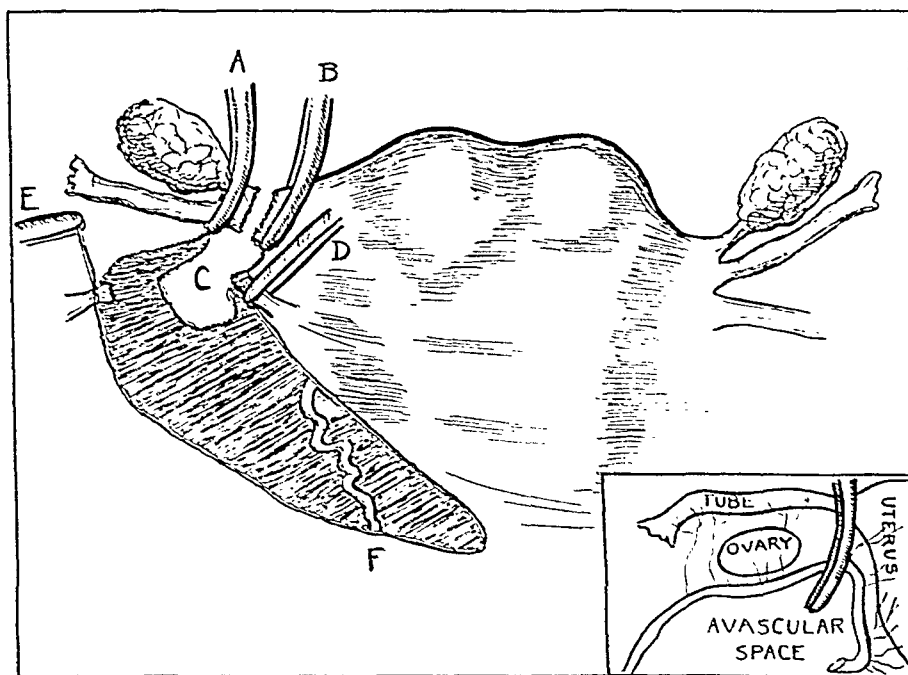


FIG. 71. Step 3. Insert shows clamp introduced from behind, under round ligament of the ovary, through the avascular space; A, B clamps on tube and round ligament of the ovary, through avascular space; broad ligament cut down into avascular space C; D, E, clamps on round ligament; F, uterine artery.

broad ligament can be cut. The broad ligament is cut between the clamps (Fig. 71, C).

Suture 2 is now inserted. It is introduced below the clamp on the cut edge of the broad ligament. The operator grasps the clamp on the broad ligament and introduces the suture from behind forward under the edge of the avascular space (Fig. 52). The needle is then brought from before backward, catching the very edge of the tube at a point  $\frac{1}{4}$  inch behind the clamp. Occasionally it is necessary to catch the edge of the round ligament of the ovary in this suture. This ligature is tied by the operator and the assistant removes the clamp slowly. This suture is left long (4 inches) and a Kut-Klamp is applied (Fig. 72).

Step 4. Clamp, ligate and cut left round ligament.



The tumor mass is now drawn to the patient's right. The left round ligament is clamped, cut and ligated, in the same manner as on the right side, using suture 3.

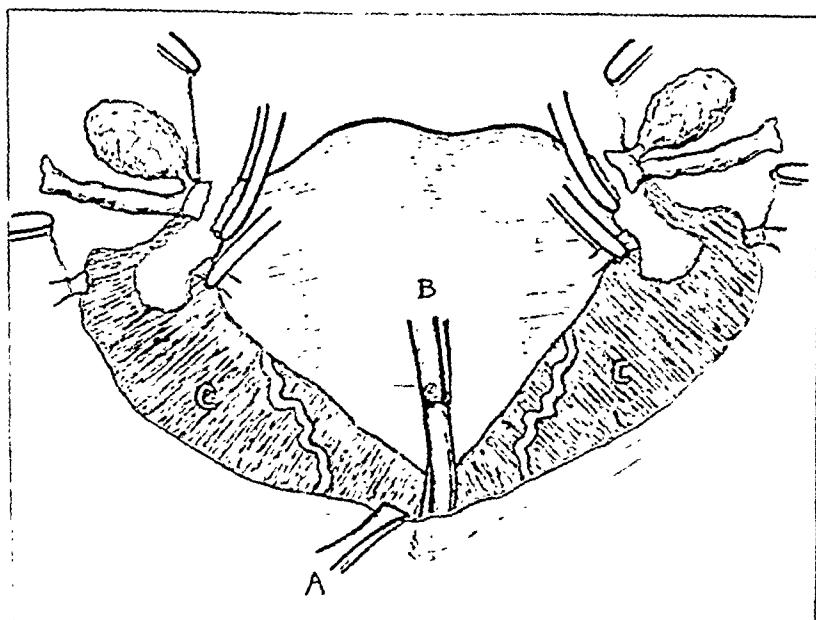


FIG. 72. Steps 4, 5 and 6. Round and broad ligaments clamped and sutured on both sides; forceps A, lifts vesicouterine fold so that scissors B, can cut dense adhesion at the midpoint; C, open vesicouterine space.

Step 5. Opening the vesicouterine fold on the left side.

The vesicouterine fold on the left side is treated in the same manner as the right except at the midpoint. At the midpoint of the vesicouterine fold of peritoneum, there is a fairly dense adhesion which does not separate very readily and must be cut in order to be separated (Fig. 72). The peritoneum is lifted at this point and the adhesion cut. The vesicouterine fold of peritoneum is then pushed downward by blunt dissection with the finger, thoroughly separating the bladder from the anterior wall of the uterus and upper part of the vagina.

Step 6. Opening of the avascular space on the left side, clamp, cut and ligate broad or infundibulopelvic ligament.

The avascular space on the left side is found, the clamp introduced from behind forward, the same as on the right side.

Two clamps are applied to the broad ligament by the assistant, the same as on the right. The operator cuts between the clamps.

Suture ligature 4 is introduced in the same way as on the right side, that is, from behind forward. The ends, however, are now towards the assistant, not towards the operator and the assistant ties this suture, the operator removing the clamp from the broad ligament. It is preferable to have the assistant tie this ligature as it is easier for him to do so. The operator may occasionally be unable to see what he is tying because the edge of the broad ligament may be under the edge of the abdominal wall on the left side.

Step 7. Suture of the left uterine artery (suture 5).

The uterus is thrown forward and the hand is introduced into the cul-de-sac and the lowermost point of the cervix is palpated. One may then judge the approximate location of the internal os on the posterior wall of the uterus. A heavy clamp is then placed on the uterine artery at right angles to the uterus and 1 cm. above the judged level of the internal os. The clamp is pushed into the edge of the uterus and as it closes, the ends of the clamp will slip off most of the uterine muscle and will grasp all the vessels (Fig. 73A).

Suture 5 is now introduced. The needle goes from before backward at the level of the internal os and at right angles to the uterus and is inserted about 1 cm. below the clamp. Some of the cervical tissue may be included with this needle but not too much. This suture is then tied by the operator. As the first knot is tightened, the assistant cuts the left uterine artery close to the clamp with a knife, and allows the knife to enter the uterine muscle (Fig. 73). If the suture is tied with two knots before the vessels are cut, the suture will not control the bleeding because it will not compress the tissues sufficiently. As the cutting is done by the assistant, the operator continues to tighten the knot; the second and third knots are applied and the ligature is cut fairly long.

Step 8. Suture of the right uterine artery (suture 6).

The same procedure is carried out on the right uterine artery except that on this side the suture is introduced from

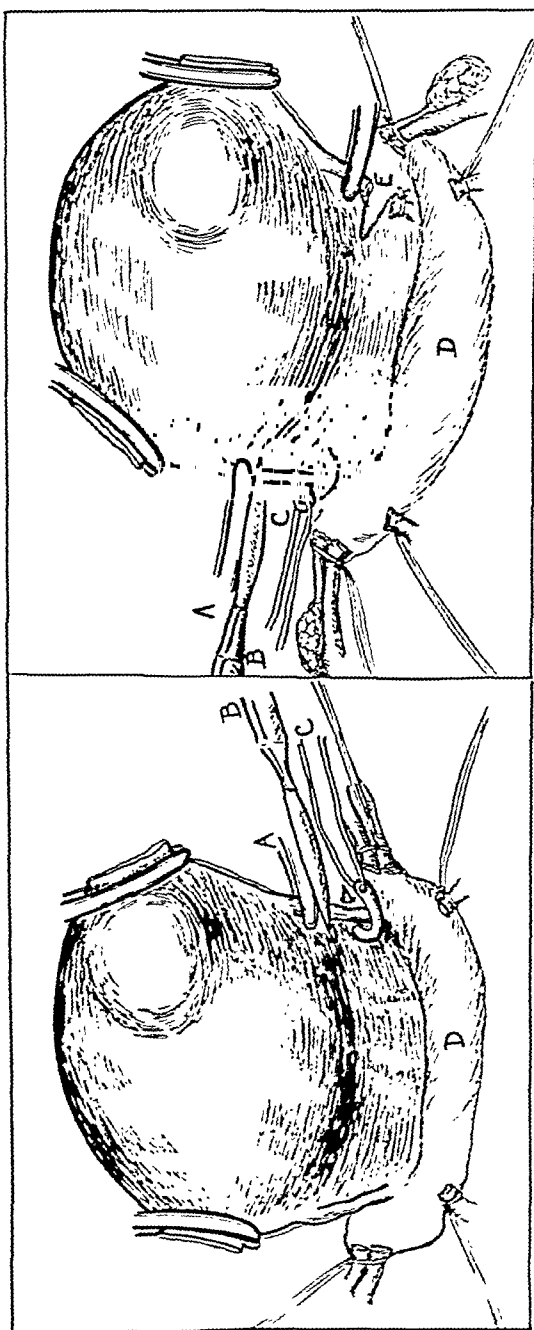


FIG. 73. Step 7. Suture of the left uterine artery, uterus drawn to right; A, clamp applied to the uterine artery; B, knife; C, needle going from before backwards passing suture ligature around uterine artery; the artery is cut while the first knot is being tightened; D, vesicouterine space.

FIG. 74. Step 8. Suture of the right uterine artery; A, clamp on uterine artery; B, knife; C, suture ligature introduced from behind forward; D, vesicouterine space; E, cut left uterine artery.

behind forward: in this way, the operator can introduce the needle at right angles to the uterus and parallel to the clamp that has already been applied (Fig. 74). The right uterine

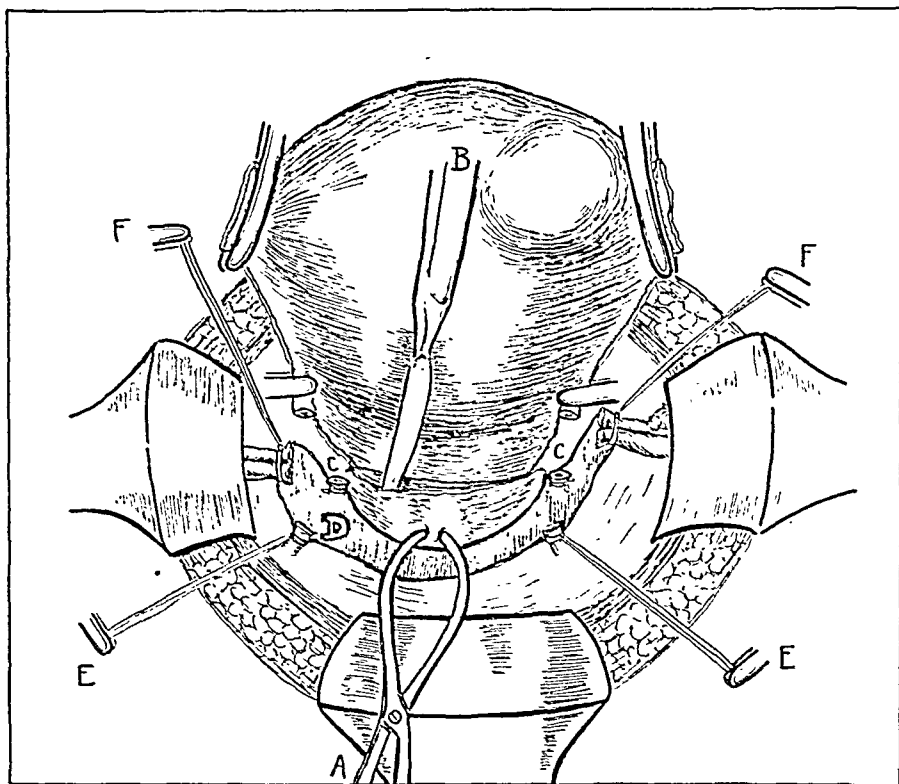


FIG. 75. Step 9. Cutting across the cervix; A, tenaculum on lower portion of cervix; B, knife cutting the cervix; C, uterine arteries; D, vesicouterine fold; E, ligature on round ligaments; F, ligatures on the tube and the round ligament of each ovary.

artery is tied by the assistant and is cut close to the clamp by the operator. *Cut the ligature fairly long and apply no clamps to the ligature on the uterine artery.* Care should be exercised in tying the uterine vessels. In tying this knot see to it that it is tight, square and that there is no tissue between the first and second knots. If some tissue falls in between the knots insert an extra knot. *Tie all sutures with three knots.*

Step 9. Cutting across the cervix.

With the six sutures the blood supply of the uterus has been controlled. The uterus can now be removed by cutting across the cervix. Before the cutting is begun, the assistant places a sponge on a stick behind the cervix. That is put there to catch

any secretion from the uterus or the cervix. This sponge stick is held by the second assistant. In cutting across the cervix the operator attempts to wedge the incision with the apex

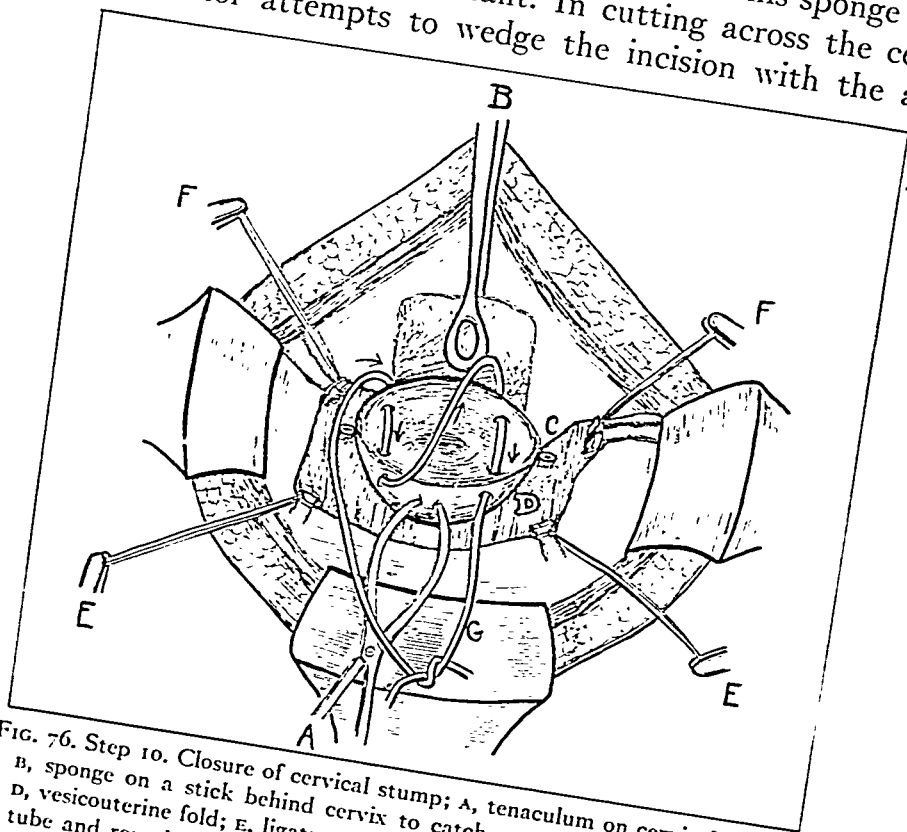


FIG. 76. Step 10. Closure of cervical stump; A, tenaculum on cervical stump; B, sponge on a stick behind cervix to catch secretion; C, uterine artery; D, vesicouterine fold; E, ligature on each round ligament; F, ligature on the tube and round ligament of each ovary; G, suture for closure enters from behind forward on the right side, then on the left, forming a figure of "8" stitch.

downward, going towards the cervical canal as far as possible. This removes a considerable portion of the cervix and also gives a good surface for coaptation. This can be done either with a knife or scissors. All secretions from the cervix or uterus should fall on the sponge behind the cervix. While the operator is cutting across the cervix with a knife, the first assistant grasps the anterior lip of the cervix with a tenaculum, so as not to lose control of the cervix (Fig. 75). The uterus and the scissors or knife used are discarded; the sponge behind the cervix is also discarded and a new one introduced. The operator washes his hands before he goes back into the oper-

active field. The cervical canal is sterilized with iodine on an applicator and the applicator is discarded. The excess iodine is wiped away with a sponge on a stick and the sponge is discarded.

#### Step 10. Closure of the cervical stump.

Suture 7 is used, No. 2 plain catgut, cut in two, on a cutting needle (spear pointed needle). A cutting needle is used for this suture because there is great difficulty pushing a round needle through the cervix. The cervix is closed with a running figure of "8" stitch. This suture is introduced from behind forward beginning on the posterior lip of the right side of the cervix and emerges close to the center of the cervix (Fig. 76). The needle is introduced into the cut edge of the anterior lip, going from behind forward, coming out on the anterior wall of the cervix. The operator holds the two ends of this suture and introduces the needle into the posterior and then into the anterior lip on the left side. This suture is tied and left very long. A Kut-Klamp is applied and the end of this suture is bound around the self-retaining retractor to hold the cervix in the wound. Remove the tenaculum (Fig. 76, A).

#### DONT'S

1. Don't have the needle enter the cervical canal.
2. Don't have the mouse-tooth forceps touch the cervical canal.
3. Don't touch the uterine artery with the needle or forceps.
4. Don't touch the ligature on the uterine artery with the needle or forceps.

Step 11. Suture of round and broad ligaments to cervical stump on left side.

Suture 8 is introduced through the posterior lip of the cervix from behind forward (Fig. 77, A); it emerges near the center of the cervix. It is brought over the edge of the broad ligament and grasps a small piece of peritoneum in the avascular zone (Fig. 77, B). It goes over the edge of the round ligament and the needle is introduced (Fig. 77, C) into the anterior lip of the

cervix. The two ends of this suture (Fig. 77, A and c) are held by the assistant. The ligatures on the round and broad ligaments, D and E, are drawn to the patient's right by the assistant

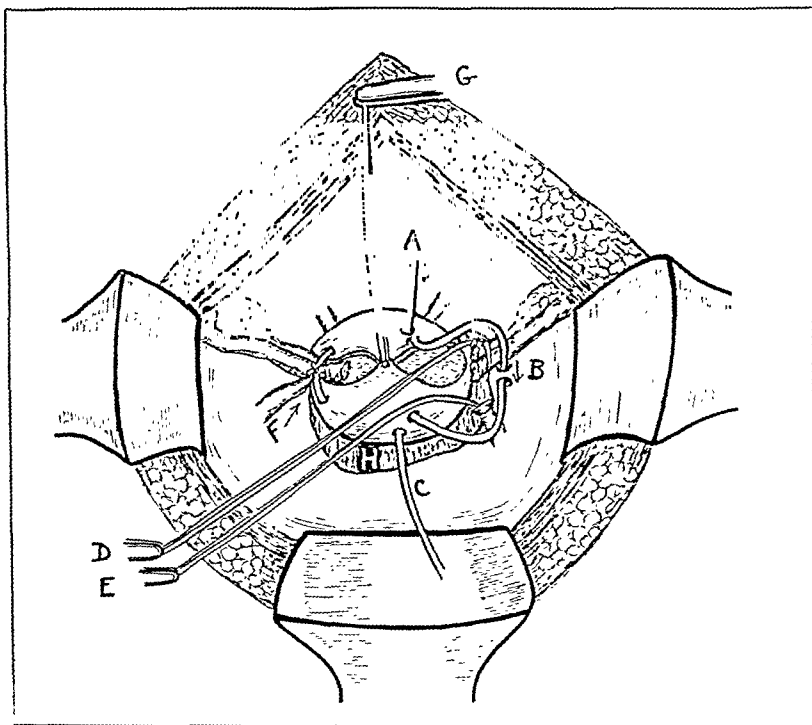


FIG. 77. Steps 11 and 12. Suture of the round and broad ligaments to the cervical stump; suture A is passed from behind forward grasping cervix behind B, going through avascular space, c, grasping anterior lip of cervix. As this suture is drawn taut the ligatures D and E on the round and broad ligaments are drawn medially so as to be included in the ligature; F, ligature on the right side completed; G, suture from step 10 which closed cervical stump; H, vesicouterine space and fold.

while the operator ties suture 8. This suture pulls the broad and round ligaments into the cervical stump. All three sutures are then cut.

Step 12. Suture of the round and broad ligaments to the cervical stump on the right side.

The round and broad ligaments are sutured (suture 9) to the cervical stump in the same manner as on the left, except that the assistant ties the ligature and the operator draws the round and broad ligament suture toward the patient's left.

Step 13. Peritonealization of the cervical stump (suture 10).

This suture is the other half of suture 7. It is of No. 2 plain catgut, cut in two, on a small Mayo needle. This suture draws the peritoneum over the cervix. Suture 7 is left long

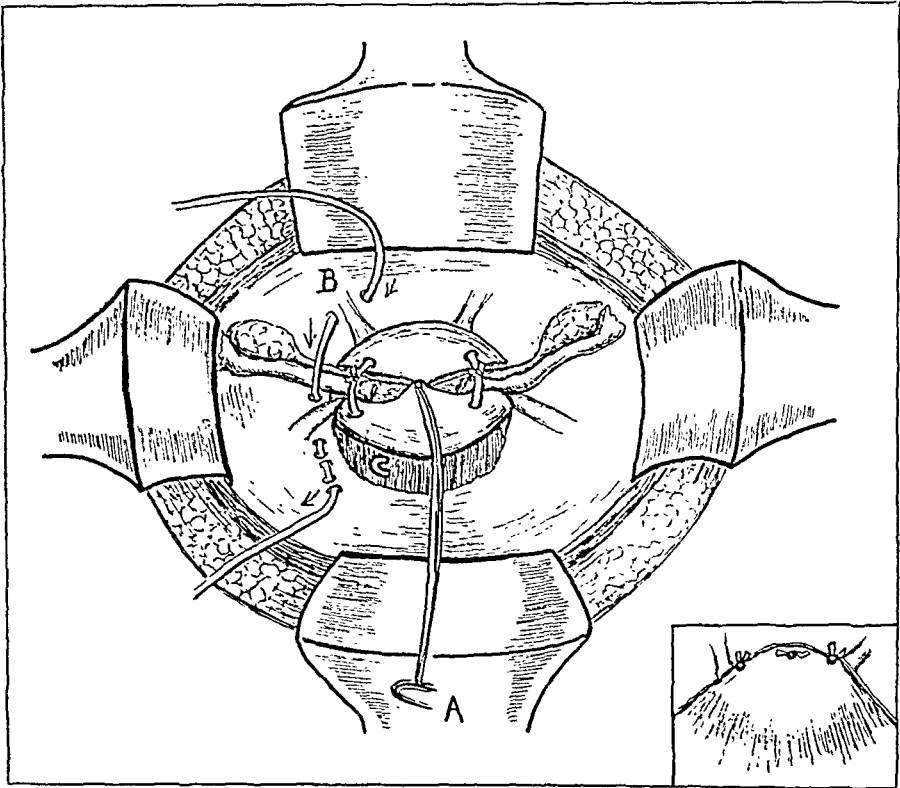


FIG. 78. Steps 13 and 14. Peritonealization of the cervical stump. A, suture 7 on cervical stump; B, right uterosacral ligament. Suture goes through right uterosacral ligament from left to right, then passes through edge of round ligament and finally catches the edge of the vesicouterine fold; C, when this is tied it draws the edge of vesicouterine fold back to the uterosacral ligament. Step 14. Same procedure is carried out on the left side. Insert shows last stitch catching loose edge of vesicouterine fold and closing over all raw surfaces.

and controls the cervix. The right ovary is lifted to the patient's right with a spatula retractor or sponge stick, exposing the right uterosacral ligament. The operator grasps the right uterosacral ligament with a mouse-tooth forceps and the needle with suture 10, is passed through it from left to right (Fig. 78). The needle is drawn out and passed through the edge of the round ligament. The suture goes from behind forward. The suture then takes a third bite in the cut edge of the vesicouterine fold of peritoneum. The third bite enters on the peri-



toneal surface and emerges on the peritoneal surface, so that when the suture is tied to the end in the uterosacral ligament, it will bring peritoneum to peritoneum and no raw surface presenting. This suture does two things: (1) it peritonealizes the cervix, (2) it lifts the right ovary to the patient's right and holds it there. This suture is cut and left long with a Kut-Klamp on its end.

Step 14. Take the same suture and carry out the same procedure on the left side, catching the left uterosacral ligament, from right to left, left round ligament and cut edge of the vesicouterine fold on the left side. This suture is tied, and the end clamped. Holding these two sutures, one controls the cervical stump. Suture 7 is now cut and as many sutures as necessary may be inserted to cover the raw surface of the cervix, suturing the vesicouterine fold of peritoneum to the posterior wall of the cervical stump (Fig. 78 insert).

This routine is for hysterectomy without removing the tubes and ovaries. If the tubes and ovaries must be removed, the only change in technique is that instead of placing the clamps, in Step 3, on the broad ligament, they are placed through the same opening but further out on the infundibulopelvic ligament. When this is done the infundibulopelvic ligaments occasionally cannot be brought down to the cervical stump in Step 11, in which case they are buried with a pursestring suture and the rest of the peritonealization is carried out as described. Many believe that the cervix is sutured to the round and broad ligaments as a support for the cervix. This is not so. The suture of the cervix to the round and broad ligaments is simply an aid to peritonealization.

#### COMPLICATIONS THAT MAY ARISE DURING THE OPERATION

*Bladder Injuries.* In doing a hysterectomy, *always think of the bladder.* Never forget it until the operation is finished. As the peritoneum is opened, think of the bladder. After a hysterectomy always examine the bladder carefully to be sure no injury has taken place. These injuries are not serious, if recognized and properly sutured. The mortality in cases with recog-

nized and treated bladder injury is not materially higher than in any other gynecological procedure. If there is any question as to an injury to the bladder, treat it as if it were injured. When the injury is disregarded, the patients usually die of a peritonitis.

For closure of the bladder wounds, interrupted or continuous sutures of fine chromic catgut on an intestinal needle are used. This suture catches all the layers of the bladder but does not enter the mucosa of the bladder. If the mucosa is entered, the catgut will act as a nidus for a stone in the bladder. A second layer of continuous sutures should be placed over the first. It is better to use two or three layers to close an injury to the bladder. Drain all cases of bladder injury through the vagina or through the abdomen. A retention catheter is inserted in all cases where the bladder is injured and should be allowed to remain for seven to ten days.

*Ureteral Injuries.* Intraligamentous and cervical fibroids may dislodge the ureter and the latter may be injured. A fibroid differs from carcinoma in that it does not surround the ureter; it dislodges it but the ureter is always on the surface. To avoid injury to the ureter in removing these fibroids, stick close to the tumor mass. In removing these tumors do not cut any structure that looks like a collapsed vein until it has been traced to its origin, or the ureter has been identified. If the ureter is cut across, there are three methods of procedure: (1) cut the upper end of the ureter at an angle and invaginate the upper into the lower end (Fig. 79) and (2) ligate the proximal end of the ureter with a heavy silk ligature; this will cause the kidney to cease to function. (3) If the ureter has been lengthened by the tumor and the bladder is sufficiently high, the ureter may be implanted into the fundus of the bladder using the same technique as when the proximal end of the ureter is invaginated into the lower end of the ureter. The opening in the bladder should be closed around the ureter in two layers.

Kelly and Cullen recommend that where there is a question as to the ureter having been injured and it cannot be dissected

out, the bladder should be opened and a catheter introduced from below up to identify the ureter. That is a procedure to remember and the less often used, the better.

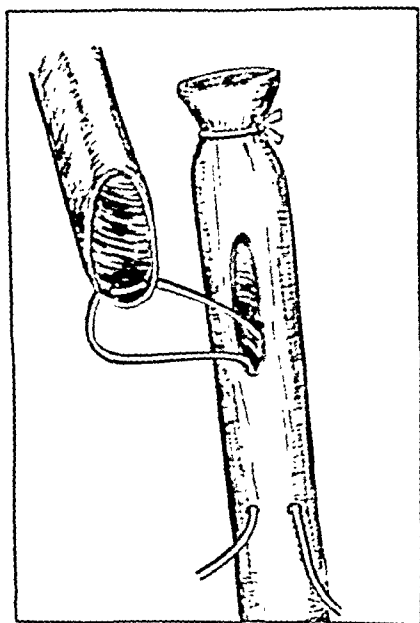


FIG. 79. Invagination of the upper into the lower end of a cut ureter.

*Operative Complications to the Rectum.* The rectum or sigmoid may be adherent to the tumor mass, lifted out of the pelvis and may be injured during the operation. There may be a muscular tear or a tear extending into the lumen of the bowel. If there is any question of injury treat the bowel as if an injury had taken place. If the adhesions between the tumor and the bowel are dense, *leave a piece of tumor on the bowel rather than a piece of bowel on the tumor.*

Muscular tears of the rectum should be closed with sutures of fine chromic catgut. If the bowel is opened it should be closed in two or three layers with fine chromic sutures. The gloves, needles and instruments used for the closure should be discarded. Drain all these cases vaginally or abdominally but do not put the drain over the suture line. Drained sigmoid injury cases may develop a fistula. If there is no tuberculosis of the intestine present this fistula will usually close spontaneously.

*In rectal injury cases the patient is to receive no fluids by rectum, no enemas, no cathartics.* All rectal injury cases should have a large rectal tube inserted about the point of injury whenever possible, so as to drain the bowel and remove any gas pressure from the line of suture.

### VAGINAL MYOMECTOMY

Where a pedunculated vaginal tumor complicates a multiple fibroid uterus, it is advisable to take care of the vaginal tumor first. Patients have been operated on successfully where a hysterectomy has been performed and on cutting across the cervix the pedicle of the vaginal tumor was cut across and the vaginal tumor allowed to drop into the vagina and removed from below. In this method the chances of infection are too great, because the cervix is patent, the pedicle infected and the uterine cavity may also be infected. It is far wiser to remove the vaginal tumor first and at a later date, after two menstrual periods so as to give the uterus a good chance to sterilize itself, to remove the uterus.

In the removal of the vaginal tumors, always remember:

1. The tumor is attached somewhere in the uterine cavity;
2. Other pelvic pathology may be present (pus tubes);
3. The myoma may be clean or infected; and
4. Do not lose control of the pedicle or an uncontrollable hemorrhage may occur.

As the tumor is always attached somewhere in the uterine cavity, traction on the tumor may invert the uterus and draw down a piece of fundus as part of the pedicle. In cutting across such a pedicle, one may buttonhole the fundus and cause a peritonitis.

Other pelvic pathology or pus tubes may be present. Rupture of these pus tubes may result from too great traction on the tumor mass and the uterus with subsequent general peritonitis and death.

If the pedunculated myoma is clean and the vagina is small, an incision to enlarge the vagina can be made. But if the myoma is infected, under no circumstances should an incision

in the vagina be made as it will become infected and the patient may die of sepsis. In infected myomas take every precaution not to injure any of the tissues, vagina or cervix

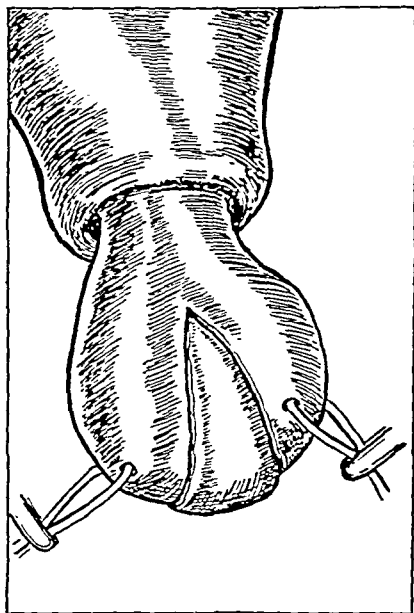


FIG. 80. Method of removing a pedunculated fibroid presenting through the cervix. Traction sutures holding tumor while a wedge shaped piece is excised from the middle.

as they may be a portal of entry for organisms. Do not curette the uterus after the removal of a pedunculated myoma for the same reason.

Do not lose control of the pedicle. The tumor may be removed piecemeal, taking portions away from the center, thus reducing the size of the mass and allowing the pedicle to become accessible (Fig. 80).

The lateral portions of the tumor can be controlled with traction sutures. Place a suture in the outer portion of the tumor mass and cut it long. Excise a wedge-shaped piece from the center, which allows a gradual approach to the pedicle. The use of suture ligatures as traction ligatures are good as they also help to control hemorrhage. It is not necessary to remove all of the pedicle, as it is not tumor tissue.

The pedicle above the tumor should be ligated if possible. If control of the pedicle is lost and it falls back into the uterine cavity with bleeding, the uterus may be packed with iodoform gauze.

Frequently in the removal of these pedunculated fibroid masses a line of cleavage is found and the tumor mass enucleated (myomectomy). When the major portion of the tumor mass is removed the pedicle is made accessible for a tonsil snare which may be slipped just over the tumor mass and closed very gradually. This slow cutting with the snare or the use of a coagulating current through the wires will help control the hemorrhage.

*[To be continued in subsequent issues.]*



# The American Journal of Surgery

is the leading independent surgical Journal. It publishes many papers read before the outstanding Surgical Societies, but it is not "the official organ" of any organization. Every manuscript is selected by the editors, as worthy of publication—nothing is published because "it was read at the meeting."

Copyright, 1937, by THE AMERICAN JOURNAL OF SURGERY, INC.

NEW SERIES, VOL. XXXVI

JUNE, 1937

No. 3

## EDITORIAL BOARD

Editor:

THURSTON SCOTT WELTON

New York

|                      |                  |
|----------------------|------------------|
| D. C. Balfour        | Rochester, Minn. |
| Carl Beck            | Chicago          |
| George R. Brighton   | New York         |
| Meredith F. Campbell | New York         |
| James T. Case        | Chicago          |
| Isidore Cohn         | New Orleans      |
| Bradley L. Coley     | New York         |
| F. A. Collier        | Ann Arbor        |
| George W. Crile      | Cleveland        |
| E. C. Cutler         | Boston           |
| R. V. Day            | Los Angeles      |
| Charles A. Elsberg   | New York         |
| Herbert C. Fett      | Brooklyn         |
| C. R. G. Forrester   | Chicago          |
| H. Dawson Furniss    | New York         |
| J. H. Gibbon         | Philadelphia     |
| Emil Goetsch         | Brooklyn         |
| Charles A. Gordon    | Brooklyn         |
| Donald Guthrie       | Sayre, Pa.       |
| A. E. Hertler        | Kansas City      |
| Louis J. Hirschman   | Detroit          |
| James M. Hitzrot     | New York         |
| Frederick C. Holden  | New York         |
| Emile F. Holman      | San Francisco    |
| J. A. Hyams          | New York         |
| R. H. Jackson        | Madison          |
| John E. Jennings     | Brooklyn         |
| W. L. Keller         | Washington, D.C. |
| H. A. Kelly          | Baltimore        |
| T. J. Kirwin         | New York         |
| Arthur Krida         | New York         |
| A. V. S. Lambert     | New York         |
| Maurice Lenz         | New York         |
| H. H. M. Lyle        | New York         |
| Jerome M. Lynch      | New York         |
| Urban Maes           | New Orleans      |
| Harrison S. Martland | Newark           |
| Rudolph Matas        | New Orleans      |
| Roy D. McClure       | Detroit          |
| H. C. Naffziger      | San Francisco    |
| C. R. O'Crowley      | Newark           |
| Louis E. Phaneuf     | Boston           |
| Eugene H. Pool       | New York         |
| Douglas Quick        | New York         |
| N. P. Rathbun        | Brooklyn         |
| H. A. Royster        | Raleigh          |
| Henry S. Ruth        | Philadelphia     |
| A. C. Scott          | Temple           |
| M. G. Seelig         | St. Louis        |
| J. Bentley Squier    | New York         |
| H. J. Stander        | New York         |
| George W. Swift      | Seattle          |
| H. L. Updegraff      | Los Angeles      |
| Grant E. Ward        | Baltimore        |
| J. H. Woolsey        | San Francisco    |

## EDITORIAL

### DANGERS OF ROENTGENOSCOPY AND METHODS OF PROTECTION\*

EVERY physician has read or heard about the many pioneer specialists in roentgenology who, after the loss of one finger after another, finally lost their lives from the spread of carcinoma which had developed as a result of antecedent injury to the skin of the fingers caused by exposure to roentgen rays repeated daily or at frequent intervals over a long period of time. It has become a habit of newspaper editors to feature each case and to glorify each successive victim as a "martyr to science." The one fortunate thing about such cases is that their number is steadily decreasing, and the reason is not far to seek. When these pioneers sustained their initial injuries, little was known about the action of roentgen rays on human tissues, and still less was known about effective means of preventing such injuries. In fact, several years elapsed after Roentgen's epoch-making discovery before the relationship between certain effects on the skin and exposure to the new rays was realized. But gradually, successive reports of similar deleterious effects caused the medical profession to understand that roentgen rays were far from harmless.

Since then, many experiments on animals and prolonged clinical observation have yielded extensive information about the changes that are induced in the tissues by irradiation under different conditions. Even laymen now know something about the danger of overexposure to the roentgen rays. Moreover, those physicians who have devoted their lives to the study of these rays or to their use for diagnosis or treatment have learned how to protect themselves and how to prevent the kinds of injury which had maimed or killed so many of their predecessors. Now that effective methods of protection are known and understood, no longer need any physician suffer injury from this cause. So true is this that,

\* From the Section on Therapeutic Radiology, The Mayo Clinic, Rochester, Minnesota.



at the present time, any physician, and especially any roentgenologist, who suffers injury from this cause convicts himself of ignorance or of unpardonable negligence, or the burden of responsibility must rest on the hospital or other institution that forces him to work under unsafe conditions. The point is that, so far as our knowledge of the means of prevention is concerned, there can no longer be any excuse for this kind of injury.

However, to this day, the number of physicians who incur injury from over-exposure to roentgen rays is much greater than is realized by the profession at large. An interesting point is that, of the total number of such injuries, the percentage among professional roentgenologists is very small indeed. The inescapable conclusion is that physicians without special training and experience in roentgenology sustain injury because they are not aware of the danger to which they are continually subjecting themselves and because they do not adopt the methods of protection without which the use of roentgen rays is fraught with hazard.

Since the war, an increasing number of internists, surgeons and general practitioners have equipped their offices with roentgenologic apparatus and have used it for the diagnosis of intrathoracic or gastrointestinal lesions, for the diagnosis and reduction of fractures, for the localization and removal of foreign bodies, or for the recognition of tumors of bone. In some instances, the physician has taken the trouble to acquire a certain amount of training, but too often his training has been confined to the instructions furnished by the manufacturer's agent who came to install the apparatus. Some physicians employ a technician to make roentgenograms, but roentgenoscopy, the reduction of fractures, and the removal of foreign bodies cannot be left to a technician, however good his training. These procedures the physician himself must conduct, if only because the weight of legal responsibility bears more directly on him. It is precisely

these procedures which involve the greatest danger.

When internists watch an experienced roentgenologist examine the stomach and duodenum of a large number of patients in an amazingly short time, it probably looks as easy as golf when played by Bobby Jones. No doubt many internists go back home asking themselves why they should refer cases to a specialist when they could themselves conduct such a simple diagnostic procedure. The only cure for such naive thinking is to give them a set of clubs and let them try to beat "old man par." However, in the case of roentgen rays, "old man par" is a suffering human being and sometimes the physician himself. This also applies to the reduction of fractures and to the removal of foreign bodies. Even in the hands of a well trained and experienced surgeon, and even when a foreign body has been accurately localized and its position charted on a cross-section diagram, its removal may prove to be an extremely difficult and time-consuming undertaking. This is just as true of roentgenoscopic procedures, the apparent simplicity of which is often deceptive. As a result, thousands of patients are daily being subjected to unnecessarily prolonged exposure to roentgen rays and, incidentally, hundreds of physicians are daily exposing themselves to the roentgen rays for an undue length of time, and often with little or no protection. True, the manufacturers of roentgenologic apparatus have incorporated a measure of protection but, in the case of roentgenoscopy, few physicians know how much effective protection actually shields them from a catastrophe which may not become apparent until months or years later. If the reader thinks this is an exaggeration, let him ask any of the physicians who have been unwitting victims of this sort of injury.

If one scans the medical writings one finds that this relatively important problem is seldom mentioned. The few articles on the subject of protection have usually been written from a physical standpoint

and are too technical for the average medical reader. Many bulky tomes on the diagnosis and treatment of fractures and encyclopedias of surgery have been published by eminent physicians, not one of whom has deigned to refer to this phase of medical practice. Only one reason can explain such surprising neglect; this is that physicians in general, including all but a few of the best known specialists, have not even been aware of the existence of this problem. The unfortunate victims are not inclined to boast of the calamity which has come upon them and which sometimes has blighted a brilliant career.

The manufacturers of roentgenologic apparatus cannot escape a share of responsibility. When has any manufacturer or his agents taken the trouble to warn physicians of the danger of overexposure? Rather, the tendency has been to minimize the danger or to avoid mentioning it for fear of losing a sale. However, since those who manufacture apparatus have not known more about the subject than the physicians themselves, their share of responsibility is small. To be fair, it should be mentioned that some manufacturers have incorporated valuable protective features, such as additional lead glass besides that which overlies the roentgenoscopic screen, automatic limitation of the fluorescent image by mechanical connection of the shutter to the screen holder, complete enclosure of the underside of the roentgenoscopic table, provision for the attachment of a rubber apron impregnated with lead (which moves with the screen and constantly separates the operator from the patient), and metal cones to confine the beam of roentgen rays and to reduce scattered radiation.

For several years the general problem of protection for the patient as well as for the physician has received much attention. In the larger countries of Europe and America, the national societies of radiology have named special committees to study the different phases of the problem and to formulate recommendations. Moreover, all these societies have had representatives on the International Committee appointed to

gather and disseminate information on protection. Since the first International Congress of Radiology, which was held in 1925, much progress in this direction has been made. Fairly comprehensive recommendations have been formulated and have been officially adopted. The advisability of speed in roentgenoscopic examinations, minimal palpation with the unprotected hand, the use of protective gloves, the minimal thickness of lead glass for roentgenoscopes have all been stressed, but nowhere can be found data that would enable one to know the limits of safety for the physician or for the patient.

It is astonishing that the writings of roentgenologists and orthopedic surgeons during the past ten years contain so little that might serve to warn the medical profession in general against the possible dangers of roentgenoscopy as used in reducing fractures and in localizing and removing foreign bodies.

The amount of radiation that a human being may safely receive over a long period has been estimated by several writers, but these estimates have not been based on scientifically accumulated data. The value of such estimates has been thrown into question by the fact that physicians practicing roentgenoscopy on a large scale, such as those at the The Mayo Clinic, have greatly exceeded the so-called tolerance dose for many years without any sign of injury from roentgen rays. It is obvious, therefore, that those who have attempted to establish the limits of safe exposure have been extremely cautious, and these limits probably can be accepted as entirely safe. But in view of the paucity of our knowledge, a thorough investigation of the problem seemed desirable for the following reasons: (1) to determine the time required to produce erythema of the operator's hands under the conditions that obtain when a fracture is reduced with the aid of the roentgenoscope; (2) to ascertain the degree of protection necessary for the operator's hands; (3) to find, from the standpoint of protection, the most effective combination of kilovoltage, milliamperage,

and filtration for the reduction of fractures; (4) to determine the protective value of various materials used in the construction of tops for roentgenoscopic tables; and (5) to suggest ways of preventing the serious injuries to the skin which have become all too common.

The problem has been studied chiefly from the point of view of the reduction of fractures, because this seemed most important. Many of the principles that apply to the reduction of fractures also apply to the localization and removal of foreign bodies, but in relation to fractures the position of the operator's hands differs from their position when dealing with foreign bodies.

Under the technical conditions of roentgenoscopy (voltage, milliamperage, filtration, and so forth) the majority of roentgenologists and dermatologists agree that exposure to 375 roentgens (measured in air) is sufficient to cause a mild erythema of the skin, at least in cases in which the patients are blond subjects. Since it was impossible to make the necessary physical measurements during the actual reduction of individual fractures, a standardized technique, such as that used under average conditions, was adopted. The technical conditions were as follows: potential, 80 kilovolts; intensity of current, 6 milliamperes; distance between the target of the roentgen tube and the top of the table, 16 inches (40.6 cm.); the table top, which was made of pine veneer, was  $\frac{1}{4}$  inch (0.63 cm.) thick. In order to avoid ruining ordinary roentgenoscopic tubes by the prolonged operation necessary for such a study, these technical factors were reproduced by means of a mechanically rectified roentgen therapy apparatus, with an air-cooled Coolidge, broad-focus, therapy tube. A potential of 80 kilovolts represents a fair average of the voltage employed in clinical procedures. As for current intensity, 6 milliamperes exceeds the current flowing from the tube under average conditions.\*

#### THE QUANTITY OF ROENTGEN RAYS REACHING THE OPERATOR'S FINGERS

When one grasps an extremity to reduce a fracture, with the patient in a horizontal position, one's fingers are beneath the extremity, while the thumb is on top or at the side of the limb. Therefore, the ionization chamber used to measure the rays was placed near the top of the table, where the fingers of the operator would be while reducing a fracture. The intensity of the rays was measured by means of a Victoreen roentgenometer, without any filtration, with an aluminum filter 1 mm. thick, and with a similar filter 2 mm. thick. The center of the ionization chamber, which corresponded to the center of the beam of roentgen rays, was situated 1 inch (2.5 cm.) above the top of the table. Under these conditions, and with rays filtered only by the table top, an exposure corresponding to the number of roentgens required to induce cutaneous erythema required seven minutes and forty-five seconds. When the rays were filtered through 1 mm. of aluminum, the exposure time for 375 roentgens (erythema time) was fifteen minutes and thirty-seven seconds, and when the rays were filtered through 2 mm. of aluminum, the exposure time for 375 roentgens (erythema time) was twenty-four minutes. It must always be remembered that, with all the other factors constant, the intensity of radiation is directly proportional to the number of milliamperes, inversely proportional to the square of the distance between the target of the tube and the fingers, directly proportional to the square of the kilovoltage, and decreases according to the degree of filtration. If these points are borne in mind, even if a different technique is employed, it is a simple matter to estimate the erythema dose for any particular set of technical factors.

---

avoid confusing the average physician, to whom long tables of figures are a nightmare. Those who might be interested may find these figures in another, more detailed article in the *American Journal of Roentgenology and Radium Therapy*.

\* The large number of measurements made in the course of this study are deliberately omitted so as to

### THE QUANTITY OF ROENTGEN RAYS REACHING THE INDEX FINGER

In most instances of injury from the reduction of fractures under roentgenoscopic guidance, the index finger is usually injured more severely than the other fingers. This is probably because the index finger lies nearest to the central and strongest portion of the beam of rays. Actual measurement showed that the quantity of rays reaching the fingers diminished as the hand was moved away from the center of the field of irradiation.

### HOW THE TOP OF THE TABLE GOVERNS THE QUANTITY OF ROENTGEN RAYS REACHING THE FINGERS

Samples of the material used for the top of fluoroscopic tables were obtained from three well known manufacturers of roentgenoscopic equipment. The top used by one manufacturer was  $\frac{1}{4}$  of an inch (0.63 cm.) thick; it was composed of three-layer plywood which was  $\frac{3}{16}$  of an inch (0.45 cm.) thick; this was covered with bakelite which was  $\frac{1}{16}$  of an inch (0.15 cm.) thick. Another top, which was  $\frac{3}{8}$  of an inch (0.88 cm.) thick, was made of a five-layer plywood which was  $\frac{5}{16}$  of an inch (0.75 cm.) thick and a layer of bakelite which was  $\frac{1}{16}$  of an inch (0.15 cm.) thick. The former was used in vertical roentgenoscopic tables, and the thicker material was used in other roentgenoscopic tables.

The top employed by a second manufacturer was made of an upper layer of bakelite which was  $\frac{3}{64}$  of an inch (0.038 cm.) thick, three-layer plywood which had a total thickness of  $\frac{1}{4}$  of an inch (0.64 cm.), and a sheet of aluminum which was 0.0005 of an inch (0.00125 cm.) thick and which, it is claimed, tends to disperse static electricity and filter out the soft rays.

The top of a well known fracture-roentgenoscopic table is  $\frac{7}{8}$  of an inch (2.24 cm.) thick and is made of five-layer plywood, the bottom and top sides of which are covered

with bakelite which is  $\frac{1}{8}$  of an inch (0.32 cm.) thick. This table top is advertised as allowing the unobstructed passage of roentgen rays, both for roentgenography and roentgenoscopy.

From actual measurements, it is apparent that the top of roentgenoscopic tables has a definite but slight protective value. But if an equivalent thickness of aluminum is added as a filter, the slight protection provided by the table top may be discounted. However, when a table top is not used, as with some applications of the Hawley-Scanlan table, the danger of injury is slightly increased because the hands of the operator can come closer to the roentgen tube without any intervening protective element.

The filtration or protective value of each table top was measured with the same ionization chamber at a uniform distance of 16 inches (40.6 cm.), the chamber being 2 or 3 mm. above the top of the table and in line with the center of the beam of roentgen rays. Although the exposure time equivalent to an erythema dose varied slightly with each table top, the thickness of the material rather than its character was the main factor in determining the protective value of each table top. The few minutes difference in erythema time between a thin table top and a thick one may seem of small consequence but, when one realizes that doses of roentgen rays are cumulative, this difference of a few minutes, repeated frequently over years of roentgenoscopic work, becomes tremendously significant, especially since the rays that pass through the thin table top are softer and, therefore, are absorbed in greater proportion by the skin. Even a thin layer of aluminum affords valuable protection. When, as sometimes occurs when a Hawley-Scanlan table is used, no material substance intervenes between the roentgen tube and the extremity under examination, the danger of overexposure is definitely greater than it is when the tube and extremity are separated by as little as two layers of ordinary pine plywood.

#### THE EFFECT OF SECONDARY RAYS

Secondary radiation from an extremity during roentgenoscopy does not play an important part in the total dose. On theoretical grounds, the part of the dose made up of secondary rays should not be large, because the voltage responsible for the secondary radiation is low and the volume of irradiated tissue is small. Usually, the proportion of secondary rays is not large, and these weak, secondary rays are absorbed by the skin of the fingers or of the hand as a whole. The weakness of the secondary rays is shown further by the fact that roentgen dermatitis of the palm of the operator's hand is rare. Nevertheless, the field of exposure should be kept as small as possible.

#### THE DOSE OF ROENTGEN RAYS REACHING THE OPERATOR'S THUMB

In order to eliminate the possibility of a difference in absorption between a wax model and human tissue, a series of absorptive measurements were made on the forearm of an adult cadaver, which was placed on the table top, with the ionization chamber 1 or 2 mm. above the skin. These measurements clearly showed that the tissues of a patient's forearm or other part of an extremity afford a large measure of protection in comparison with the dose reaching the fingers on the inferior surface of an extremity.

#### AN ATTEMPT TO SPECIFY AN IDEAL TECHNIQUE FOR ROENTGENOSCOPY

The next step was to find a combination of kilovoltage and filtration which, while affording good visibility of a fracture, would at the same time afford the operator more effective protection from excessive exposure than do the techniques commonly used. With a table top made of plywood which was  $\frac{1}{4}$  inch (0.64 cm.) thick, with a distance of 16 inches (40.6 cm.) between the target of the roentgen tube and the top of the table, and with a current of 6 milliamperes, variations of potential between

50 and 100 kilovolts, and variations of aluminum filters between 0.5 mm. and 2 mm. were tried, and the exposure time equivalent to an erythema dose was measured for each variation. These measurements show that an aluminum filter provides a large measure of protection, especially when the rays are generated at a low potential (kilovoltage). The value of a suitable filter is so obvious that easily accessible filters should be incorporated in all roentgenoscopic apparatus. Many roentgenologists say that, owing to the different conditions encountered during roentgenoscopic examinations, it should be possible to vary the quality (penetration) of the rays by changing the voltage at will. This can readily be done by modifying the electric factors, but the intelligent use of filtration affords more effective protection. In some roentgenoscopes the manufacturer has incorporated a filter, but usually this is so inaccessible that an attempt to change it is seldom made. However, possibility of changing the filter at will would often be a decided advantage. To this, it may be objected that an increase in erythema time obtained by increasing the filtration might lead to carelessness and the filter might sometimes be overlooked but, if the operator is made to realize that carelessness in this respect may later result in cancer, he is not likely to forget the importance of the filter.

In order to test the effect of variations in kilovoltage and filtration on roentgenoscopic visibility, five members of the roentgenologic staff of the clinic were invited into a room in which was a horizontal roentgenoscopic table of standard type. Twenty minutes in total darkness were allowed to permit their eyes to adapt themselves thoroughly. The fractured forearm of a cadaver was first examined roentgenoscopically by one of the writers, under technical factors unknown to the roentgenologists. The latter were then asked to write their opinion of the visibility and definition of the bony structure as brought out by various combinations of kilovoltage

and filter. Throughout these tests the distance between the target of the roentgen tube and the top of the table was kept at 16 inches (40.6 cm.), and the current flowing through the tube was constantly kept at 3 milliamperes. Each of the roentgenologists kept his opinion secret during the tests. When these had been completed, the respective opinions and comments of the five roentgenologists were tabulated. Unfiltered rays generated at a potential of 80 kilovolts were thought to give too bright a field. Rays of the same quality, but filtered through 2 mm. of aluminum, were generally thought to have the same roentgenoscopic characteristics as the former. Rays generated at a potential of 70 kilovolts and filtered through 1 mm. of aluminum were also thought to yield too bright a field. Rays generated at a potential of 50 kilovolts and filtered through different thicknesses of aluminum provoked a variety of comments, but all five roentgenologists agreed that rays of this quality would provide for satisfactory visualization of a fracture of the arm or leg.

From the foregoing tests, rays generated at a potential of about 60 kilovolts, filtered through 2 mm. of aluminum, and with a current flow of 3 milliamperes, should constitute the best technique for the reduction of a fracture of the forearm or leg under roentgenoscopic guidance, if both the visibility of the fracture and the protection of the operator are the controlling factors.

When the fingers of the operator were placed on the top of the table the exposure equivalent to an erythema dose, with rays generated at a potential of 60 kilovolts, filtered through 2 mm. of aluminum, and with 3 milliamperes of current flowing through the tube, was ninety-five minutes. The average potential employed by several other roentgenologists was about 80 kilovolts, and the average filtration was through 0.25 to 0.5 mm. of aluminum. The number of milliamperes varied with the part of the body examined, but not with the voltage. With rays generated at 80 kilovolts, filtered through 0.5 mm. of

aluminum, and with 3 milliamperes of current passing through the tube, the exposure time equivalent to an erythema dose (375 roentgens measured in air) was twenty-two minutes. Therefore, an "ideal" technique of 60 kilovolts, 2 mm. of aluminum as a filter, 3 milliamperes of current, a distance of 16 inches (40.6 cm.), and a table top made of pine veneer which was  $\frac{1}{4}$  inch (0.64 cm.) thick affords the operator's hands more than four times the protection afforded by the technique usually employed, even when his hands are in the direct path of the rays, and yet this "ideal" technique gives a better view of the fracture.

Throughout this study the emphasis has been, not on attempting to present something new, but to investigate the problem from the standpoint of effective protection for physicians who are not specializing in roentgenology, but who have to reduce fractures or remove foreign bodies under roentgenoscopic guidance. Many interns, resident physicians and general practitioners who are frequently called on to employ roentgenoscopic procedures are not aware of the danger of overexposure to themselves as well as to their patients. To repeat, the technical factors employed in the course of this investigation represent what is believed to be a fair average. These factors may be used to calculate the doses received with other techniques, but only when the conditions of exposure are identical.

#### CONCLUSIONS AND RECOMMENDATIONS

1. Too much emphasis cannot be laid on the danger, to the physician and to his patients, of reducing fractures under roentgenoscopic guidance.

2. The careless roentgenoscopist may, while reducing a single fracture, subject his hand or fingers to severe injury which may not become apparent until weeks or months later. He may thus expose himself to a dose of roentgen rays which, though less than an erythema dose, may later by its cumulative

effect result in injury to the skin. At the same time, the patient also may receive an excessive dose which may be masked by pain caused by the fracture and which may not be detected because of inflammation associated with the fracture, especially when the limb is in a cast.

3. From the standpoint of protection this investigation emphasizes the importance of the following points: speed of examination, minimal action of the roentgen tube, the significance of keeping the fingers away from the center of the beam of rays and taking advantage of the protection afforded by the thickness of the extremity under examination; all these factors make for increased safety in roentgenoscopic procedures.

4. The "ideal" technique employed in this study may be used as a basis for calculating the doses received with different techniques.

5. As much as possible, the hands of the operator should be kept out of the path of the rays while the tube is in action, especially when lead rubber gloves are not worn.

6. Unless the operator is careful to measure the dose of roentgen rays received by himself and by the patient, unless the work is closely supervised by an experienced roentgenologist, or unless all recommended protective measures are employed, the reduction of fractures or the removal of foreign bodies under roentgenoscopic guidance is strongly condemned.

7. Roentgen rays generated at a potential of 60 kilovolts and filtered through 2 mm. of aluminum, with 3 milliamperes of current flowing through the tube, a distance of 16 inches (40.6 cm.) between the target of the roentgen tube and the top of the table, and a table with a top made of pine veneer that is  $\frac{1}{4}$  inch (0.64 cm.) thick, may not be an ideal technique but, with modifications dictated by clinical indications, seems worthy of trial.

8. Roentgenoscopic apparatus should have accessible filters which can be readily changed.

9. As suggested by Hawley, the mechanical manipulation of fractures, instead of manual reduction, deserves serious consideration.

10. Since the effects of roentgen irradiation are cumulative and signs of injury may be slow to appear, each operator should keep a permanent record of the doses to which his hands have been exposed.

11. As an additional factor of safety, each operator should calculate his maximal possible exposure and regard such a total dose as actually received, even though additional protective factors may have been employed.

12. The committees on roentgen ray protection should base their recommendations on clinical as well as on physical grounds.

CLYDE A. STEVENSON,  
EUGENE T. LEDDY,  
ARTHUR U. DESJARDINS.



Subscribers to THE AMERICAN JOURNAL OF SURGERY visiting New York City are invited to make the office of the publishers (The American Journal of Surgery, Inc., 49 West 45th Street, New York) their headquarters. Mail, packages or bundles may be addressed in our care. Hotel reservations will gladly be made for those advising us in advance; kindly notify us in detail as to requirements and prices.

# MAMMOGRAPHIC RECOGNITION OF INTRACYSTIC PAPILLOMA OF BREAST\*

N. FREDERICK HICKEN, M.D., R. RUSSELL BEST, M.D. AND J. P. TOLLMAN, M.D.

OMAHA, NEBRASKA

THE recognition of papillomatous tumors of the milk ducts presents a tantalizing clinical problem. Unfortunately the variability of symptoms and the paucity of identifying physical signs accentuate the diagnostic difficulties. Even though Nature may sound a warning by producing a serosanguinous discharge from the nipple, our tests of precision, such as transillumination, soft tissue roentgenograms, aspiration biopsies and discriminatory palpation, may fail to locate the offending neoplasms. Any procedure which aids in determining the location, size and characteristics of these papilliferous growths is certainly to be desired.

An appreciation of the morphological characteristics of these papillomatous neoplasms affords a rational explanation of the varied clinical syndromes which they produce. A true papilloma is a localized overgrowth of the epithelial cells which line the lactiferous ducts and acini. The proliferating epithelium grows more rapidly than its connective tissue substratum and invaginates into the ductal lumen. As the tumor grows it produces a pressure dilatation of the confining duct, thus forming a localized cystic cavity. Occasionally a papilloma does arise from the wall of a preformed cyst but the great majority originate in the ampullic segments of the larger milk ducts. They grow very slowly and are usually solitary. Multiple papillomata are, however, not uncommon for they occur much more frequently than is usually appreciated. Serial sections of the breast<sup>1</sup> and contrast mammograms<sup>3</sup> have adequately demonstrated this point. When multiple, these neoplasms may arise in

different segments of the same ducts or in other lobules of the same or opposite breast.

The recognition of papillomatous neoplasms is difficult as they do not produce pathognomonic symptoms. The most characteristic complaint is that of a bloody discharge from the nipple but this occurs in so many other pathologic conditions that it has but little diagnostic value unless confirmed by other evidence. A hemorrhagic or serosanguinous secretion may be associated with a malignancy,<sup>7</sup> papilloma of the ducts, Paget's disease, trauma, fibroadenoma, tuberculosis, chronic cystic mastitis<sup>6</sup> and senile parenchymal hypertrophy. To complicate matters further, a papilloma may bleed and yet the blood will be confined to the milk duct for the tumor may completely obstruct the ductal outlet. Deaver and McFarland<sup>2</sup> found that 50 per cent of papillomata produced a bloody discharge, 25 per cent a clear serous fluid, and the remainder did not form any type of secretion. It is apparent that the nature of the discharge has practically no diagnostic value in the recognition of duct papillomata.<sup>7</sup>

## PAIN

Mastalgia is seldom associated with a papilloma for these tumors grow so slowly that but slight intraductal pressure is exerted. Occasionally a sudden, sharp pain may mark the onset of an intracystic hemorrhage. Multiple papillomata are more prone to cause discomfort than a single one, but pain seldom causes the patient to seek relief, and when present it has no diagnostic value.

\* From the Departments of Surgery and Anatomy, and the Department of Pathology, University of Nebraska College of Medicine.



## PALPABLE TUMORS

Unfortunately the very nature of these neoplasms renders their detection difficult. They are usually small, compressible, and frequently cannot be differentiated from the surrounding matrix. Occasionally they attain sufficient size that they may be palpated. In such instances, the tumor is usually situated in the ampullic segment of the ducts with its long axis radiating from the nipple. Pressure may elicit a point of tenderness or express secretions from the nipple. Even when the diseased lobule has been identified by the escaping discharge one can seldom feel the offending tumor. Transillumination will occasionally outline a large papilloma particularly if it is surrounded by a blood clot, but generally the tumor possesses the same translucency as the surrounding breast structures and differentiation is very difficult. Soft tissue roentgenograms, likewise, fail to isolate the neoplasm.

The failure of these papillomata to produce identifying syndromes combined with their occasional tendency to undergo malignant transformation certainly creates an interesting problem. In order to facilitate the recognition and location of these tantalizing neoplasms, a new method of roentgenographic visualization has been developed.<sup>3,4</sup> By this procedure, termed mammography, an accurate anatomical pattern of the ductal system can be obtained by introducing a suitable contrast medium. Any pathological condition which alters the size, shape or conformation of the injected ducts can be readily detected by subsequent stereoscopic roentgenograms.

Papillomata can be readily visualized by these mammographic studies. The stoma of the offending duct, which can be identified by the escaping serosanguineous discharge, is cannulized and injected with thorotrast and immediate stereoscopic roentgenograms are made. The entire duct and all of its branches are graphically outlined. Since these papilliferous growths protrude into the lumina of the ducts, they

produce characteristic "filling defects" which can be readily detected. The technical simplicity and the diagnostic value of these mammograms can best be portrayed by the presentation of typical cases.

UNILATERAL CENTRALLY PLACED  
PAPILLOMA

CASE 1. P. P., housewife, forty-four years of age, entered the hospital complaining of a serosanguineous secretion escaping from the left nipple of six weeks duration. Any pressure or manipulation increased the amount of discharge. She had nursed each of her three children and had provided a bounteous supply of milk. Trauma and infection were not causative agents.

The breasts were small, atrophic and presented multiparous characteristics. There were no palpable tumor masses or points of localized tenderness. The subareolar tissues felt normal but slight pressure expressed a serosanguineous discharge from one of the centrally placed milk ducts and a clear serous fluid from the others. Transillumination and soft tissue roentgenograms did not outline the tumor or show existing abnormalities. The only pathological sign was the serosanguineous discharge which escaped from an apparently normal breast.

The nature of the discharge, the absence of a palpable neoplasm and the age of the patient suggested the diagnosis of a ductal papilloma. This, however, was merely conjectural. Having thus far failed to visualize the offending neoplasm, contrast mammograms were employed. The nipple was thoroughly cleansed with alcohol, not only to render the field aseptic but to remove any incrustations or plugs of inspissated material which might be obstructing the orifices of the lactiferous ducts. A gentle stripping massage expressed one drop of bright red blood. The offending estuary was cannulized by a blunt No. 26 gauge needle and 2 c.c. of thorotrast were introduced. The patient was immediately placed in a lateral recumbent position with the injected breast supported by a Meyers angle board and a lateral stereoscopic roentgenogram was made. The diseased duct and all of its ramifying lacteals were graphically outlined. The portion of the duct traversing the nipple was smooth, regular and of a uniform diameter. The ampullic segment, however, contained a definite "filling defect" which was interpreted as being a tumor displacing the

contrast medium (Fig. 1. A). The neoplasm was exceedingly small, well circumscribed and had not destroyed the ductal continuity. Dr. H. B.

jury, cracked nipple, "caked breast" or infection. She had nursed each of her four children, the youngest of whom was two years of age.

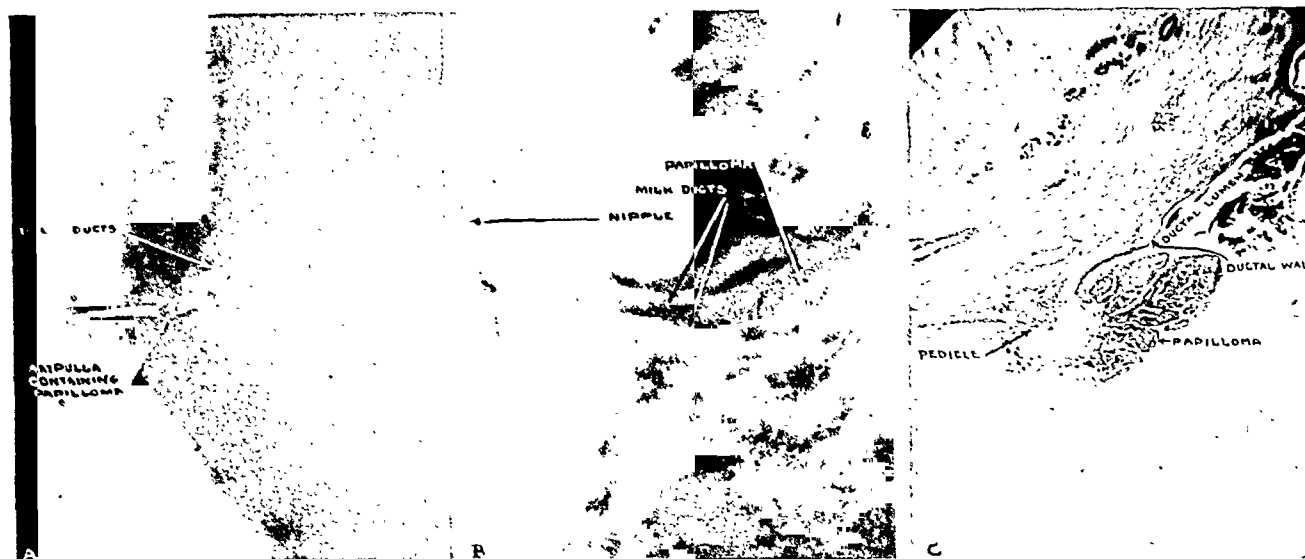


FIG. 1. Case 1. A, 2 c.c. thorotrast injected into the bleeding duct; the "negative shadow" indicates a tumor protruding into the ductal lumen; B, photograph shows the papilloma in the duct; C, photomicrograph of the papilloma showing its attachment to the duct wall.

Hunt made the roentgenographic diagnosis of a benign papilloma. The lacteals and acini appeared normal.

In order to excise the papilloma it would have been necessary to destroy the continuity of the regional ducts, therefore, a simple mastectomy was performed. A small papilloma, about 0.25 cm. in diameter, was found arising from the wall of a centrally placed milk duct (Fig. 1. B). Its base was not indurated nor was there any evidence of malignant transformation (Fig. 1. C).

#### UNILATERAL PERIPHERALLY PLACED PAPILLOMA

CASE II. L. McC., a twenty-eight year old housewife, was worried about her "bleeding breast." Three months before, while adjusting her brassiere, she had observed a drop of bright red blood seeping from the right nipple, but as there was no pain and no palpable tumor she ignored the incident. Two weeks later a similar discharge was observed but self-examination again failed to reveal any cause for concern. The bleeding increased in frequency until it became a daily occurrence. She finally consulted her physician who, being unable to feel any tumor or find any point of localized tenderness, told her that such troubles were "inconsequential." The hemorrhagic discharge, however, persisted. There was no history of in-

Both breasts were large, pendulous and obese. No tumefaction, ulceration or discharge from the nipple was seen. The milk ducts were distended but compressible. Even the most meticulous and painstaking palpation failed to locate the tumor and no point of localized tenderness was found. Pressure on the upper outer quadrant of the right breast expressed a dram of frank blood from one gaping estuary. The entire mammary gland was translucent and no semblance of a papilloma could be found either by transillumination or soft tissue roentgenograms.

An accurate diagnosis was impossible for the only abnormal finding was the bloody discharge from the nipple. Having failed thus far to identify the causative agent, mammographic visualization studies were employed, after introducing 4 cms. of lipoiodine into the bleeding duct. The resulting mammogram accurately visualized the diseased duct and all of its tributaries. The ampullic portion was dilated to five or six times its regular size while the terminal lacteals and acini appeared normal (Fig. 2. A). No "filling defects" were seen. Six other ducts were also injected and while their ampullae appeared to be slightly dilated, none of them had undergone such an extensive cystic degeneration as the one which emitted the bloody discharge. The localized cystic dilatation of the offending duct combined with the

hemorrhagic discharge suggested the diagnosis of a ductal papilloma.

A mastectomy was performed and the ac-

came persistent. She immediately consulted her physician but he was unable to determine the cause of the bleeding.

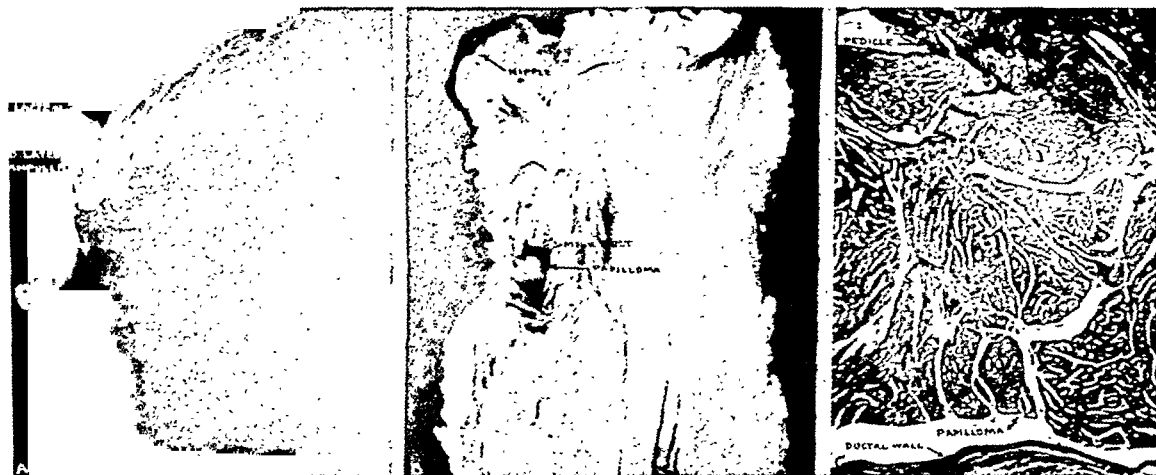


FIG. 2. Case II. A, 4 c.c. lipiodine injected into the bleeding duct; note the dilated ampulla and branching lacteals; no negative shadow was seen; B, the papilloma can be seen protruding in the ductal lumen; C, histologically the tumor was a benign papilloma.

companying photograph shows the small papillomatous neoplasm which was projecting into the dilated ampulla (Fig. 2. B). The duct did not contain any blood nor could a point of localized bleeding be found. Histologically, the tumor proved to be a benign papilloma (Fig. 2. C).

This case presented an interesting diagnostic problem. Why did this particular papilloma fail to produce the characteristic "filling defect" which was observed in the previous case? The answer is obvious. Lipiodine is such a dense radiopaque material and has such a high viscosity that it forms an impenetrable covering around the tumor and thus obscures it. For this reason, thorotrast is a much better mammographic agent.

#### MULTIPLE AND BILATERAL PAPILLOMATA

CASE III. R. S., female, stenographer, forty-one years of age, complained of a "bleeding breast." On several occasions during the previous three years she had observed a few drops of blood-tinged fluid escaping from the right nipple. Frequent self-examinations failed to demonstrate any abnormalities so she thought the bleeding was caused by the incipient menopause. Two weeks before admission, however, she grew alarmed for the bloody discharge be-

On examination both breasts were found to be small, soft and spongy. In the outer lower quadrant of the right breast a small compressible tumor could be felt. When pressure was exerted on this cystic mass, the regional ducts became tense and distended but no secretions were expressed from the nipple. While examining the upper medial quadrant of the same breast, a few drops of fresh blood escaped from a peripherally placed duct. No tumor mass or area of localized tenderness could be palpated. Transillumination and soft tissue roentgenograms again failed to demonstrate any abnormalities. The left breast, as well as the right, was asymptomatic and appeared to be normal.

In view of our previous experiences, it was believed that the cause of the hemorrhagic discharge could be determined by contrast mammograms. The bleeding estuary was readily cannulized and 1 c.c. of thorotrast was introduced. The roentgenogram gave a vivid anatomic pattern of the injected ducts. The dilated ampulla was distorted by a large filling defect. This deformity was interpreted as being a pedunculated papilloma protruding into the ductal lumen. In order to preclude the possibility of an artefact, such as an air bubble, an additional 3 c.c. of thorotrast was injected into the same duct. The contrast medium was forced beyond the obstructing tumor and entered the terminal ducts and acini. Not only was the ampullar tumor still visible but a second and similar deformity was ob-

served at the junction of two smaller tributaries (Fig. 3. A). The diagnosis of multiple papillomata was very evident.

a "negative shadow" or "filling defect" could be seen. It maintained a constant size, shape and position in subsequent mammograms and

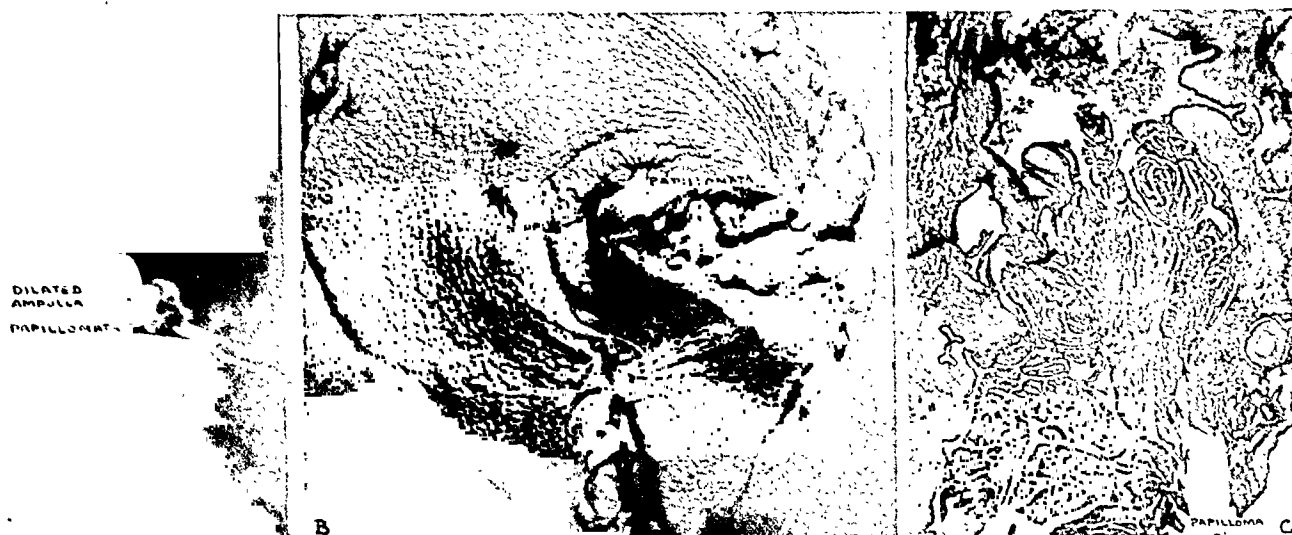


FIG. 3. Case III. Right breast. A, bleeding duct injected with 1 c.c. thorotrast; observe the two "negative shadows" in the ducts; B, the offending duct contains two papillomata; C, the papilliferous tumor practically occludes the ductal lumen; benign papilloma.

Hoping to familiarize ourselves with the ductal pattern of a normal breast, contrast mammograms were made of the asymptomatic left mammary gland. Four centrally placed lactiferous ducts were cannulized and injected with 10 c.c. of thorotrast. The stereoscopic mammogram revealed some startling and com-

was interpreted as being a pedunculated papilloma arising from the walls of a preformed cyst.

After making the mammographic diagnosis of multiple papillomata in one breast and a large cyst undergoing papillomatous transformation in the other, a bilateral mastectomy was performed.

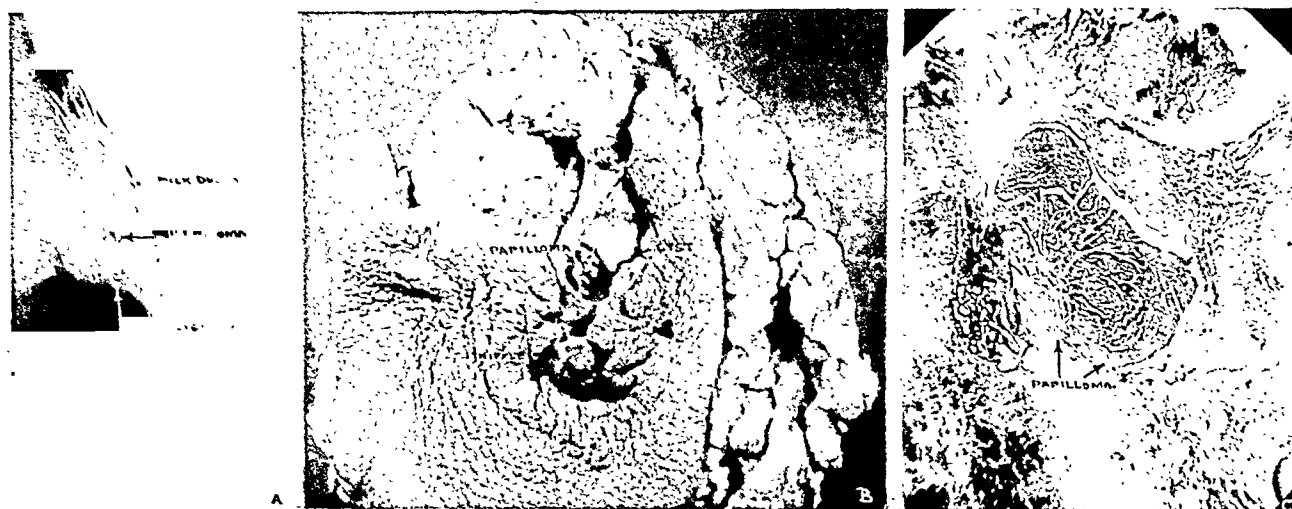


FIG. 4. Case III. Left breast. A, thorotrast outlines a large cyst which contains a "negative shadow"; B, parent cyst and pedunculated papilloma are exposed; C, photomicrograph of benign papilloma.

pletely unexpected findings. The contrast fluid had entered a large cystic cavity which was formed by a confluence of the injected ducts (Fig. 4. A). The delimiting wall of the cyst and the communicating regional ducts were clearly visualized. In the central portion of the cavity

The accompanying photographs verify the mammographic diagnosis. In the right breast the ampullic papilloma was soft and friable (Fig. 3. B). There was one small hyperemic area which was covered with a recently formed blood clot, obviously the site of hemorrhage.

The tumor mass was attached to the duct wall by a broad non-infiltrating base. Two centimeters farther along this duct, at the junction of two smaller branches, was a kindred tumor which protruded into both ductal lumina so as to completely obstruct them. No evidence of malignancy was found (Fig. 3. c).

The left breast also presented some interesting findings. In the subareolar area was a dilated cystic cavity which communicated with several adjacent ducts, and arising from its wall was a small papilliferous tumor which projected into the main cavity (Fig. 4. b). Obviously this neoplasm originated from the wall of a preformed cyst. The papilloma was soft, friable and spongy and there was no evidence of intracystic or intraductal hemorrhage. Such an observation is interesting for this tumor was about three times larger than the bleeding neoplasm of the opposite breast. Its histological structure was that of a benign papilloma (Fig. 4. c).

#### CONCLUSIONS

Certain generalizations can be drawn from these studies.

1. Bleeding from the nipple constitutes a distinct warning that some profound pathologic change has taken place in the breast. It may announce the presence of carcinoma, papilloma, Paget's disease, cysts, infections, traumatic degeneration, or vicarious menstruation.<sup>5</sup> Inability to determine the exact cause affords no license for passive conservatism as incurable sequels may follow.

2. A hemorrhagic or serosanguineous discharge from a breast in which no tumors can be palpated is most likely to be caused by a duct papilloma. These tumors are soft, compressible and spongy and hence cannot be readily discerned by palpation. Positive findings are valuable, negative ones are meaningless. In none of our patients were the neoplasms palpable in spite of the fact that one was as large as a marble.

3. Papillomatous tumors are often multiple. They may arise in various segments of the same duct or in other ducts of the same or opposite breast.

4. The size of the papilloma bears no relationship to its symptomatology. A small pinpoint tumor may bleed rather profusely (Case i), while much larger ones may be asymptomatic (Case iii).

5. Papillomatous tumors usually cannot be visualized either by transillumination studies or by soft tissue roentgenograms. The neoplastic tissues have the same translucency as the surrounding matrix and differentiation is seldom possible. Occasionally, a large intracystic hemorrhage will permit transillumination identification.

6. The absence of symptoms and physical findings is no assurance that papillomata are not present.

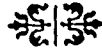
7. Papillomatous neoplasms can be readily visualized by contrast mammograms. The tumor produces a characteristic "filling defect" of the ductal lumen. In the 3 cases presented the papillomata were not palpable, nor were they seen on transillumination or soft tissue roentgenograms and yet they were clearly visualized by mammographic studies. Thorotrast is the most suitable contrast agent and has been used in more than 375 mammograms. The escaping discharge accurately locates the offending duct which can be easily cannulized and suitable quantities of thorotrast introduced. Any discharge from a non-lactating breast, whether serous, serosanguineous, hemorrhagic, purulent, or "milky," demands mammographic studies. Such pathological conditions as carcinoma, cysts, galactoceles, papillomata and breast abscesses have been visualized and diagnosed by contrast mammograms. While papilloma of the milk ducts is essentially a benign epithelial tumor, it may undergo carcinomatous transformation if permitted to pass through its evolutionary cycle.

8. These visualization mammograms not only possess great diagnostic value but they aid the surgeon in determining the proper type of corrective treatment. They accurately locate the offending tumor and thus indicate the breast lobule which is to be excised. Nothing is more embarrassing than to remove a segment of the mam-

mary gland and then have the pathologist report that no papilloma could be found. Multiple tumors can be recognized pre-operatively, in which event a simple mastectomy replaces local excision of the neoplasm.

#### REFERENCES

1. CHEATLE, GEO. L. and CUTLER, M. Tumors of Breast, Their Pathology, Symptoms, Diagnosis and Treatment. London, E. Arnold and Co., 1931.
2. DEEVER, J. B. and McFARLAND, J. The Breast, Its Anomalies, Its Diseases and Their Treatment. Philadelphia, P. Blakiston's Son and Co., 1917.
3. HICKEN, N. F. Mammography: the roentgenographic diagnosis of breast tumors by means of contrast media. To be published in *Surg., Gynec. and Obst.*
4. HICKEN, N. F. Aeromammography: the radiographic visualization and diagnosis of breast tumors following air insufflation. To be published in *Ann. Surg.*
5. HIRSCHBERG. Vicarious menstrual bleeding from the nipple. *Centrabl. f. Gynak.*, 38: 939, 1919.
6. MILLER, E. M. and LEWIS, DEAN. The significance of a sero-hemorrhagic or hemorrhagic discharge from the nipple. *J. A. M. A.*, 81: 1651-1657, 1923.
7. STOWERS, J. E. Sanguineous discharge from the nipple and its significance in relation to cancer of the breast. *Surg., Gynec. and Obst.*, 61: 537-545 (Oct.) 1935.



INFECTIOUS diseases is one of the great tragedies of living things—the struggle for existence between different forms of life. Man sees it from his own prejudiced point of view; but clams, oysters, insects, fish, flowers, tobacco, potatoes, tomatoes, fruit, shrubs, trees, have their own varieties of smallpox, measles, cancer, or tuberculosis. Incessantly, the ruthless war goes on, without quarter or armistice—a nationalism of species against species.

Rats, Lice and History by Hans Zinsser.

# LYNCH'S SIMPLIFICATION OF PERINEAL EXCISION OF RECTUM

JEROME M. LYNCH, M.D., F.A.C.S. AND G. JOHNSON HAMILTON, M.D., M.R.C.S.  
PRELIMINARY REPORT

NEW YORK

**P**ERINEAL excision of the rectum for the eradication of carcinoma was first performed some two hundred years ago. Since then the modifications in technique have been legion. Nevertheless three great problems still confronted the surgeon performing this operation: (1) to find a suitable anesthetic, (2) to control the secondary hemorrhage, and (3) to avoid postoperative infection.

The first of these difficulties was overcome when low spinal anesthesia became established. Anesthesia so induced permits of ample time for the procedure without endangering the life of the patient. We have now devised an operative technique which appears to overcome the other two problems, hemorrhage and infection, which are in reality complementary. Our routine is as follows:

## PREPARATION

The patient is prepared in the same way as for any major operation. The desiderata are that the subject shall come to the operating table in the best condition possible in the time circumstances allow. To this end attention is directed towards building up the hemoglobin, the body fluids and the salts; to protecting the liver with glucose; and to eliminating the toxins from the renal and intestinal tracts.

The lower bowel is emptied by means of castor oil administered by mouth in the morning, and by cornstarch enemas in the evening. It is important that no purge be given within forty-eight hours of operation as that interval is essential for the elimination from the kidneys of any toxins liberated by such medication. The last enema should be given the night before operation.

*Preoperative Medication.* A good night's sleep should be insured by the administration of a hypnotic. A full dose of morphine coupled with atropin grain  $\frac{1}{150}$  should be given one-half hour before operation.

## OPERATIVE PROCEDURE

*Stage 1.* Following low spinal anesthesia, with the patient in the left Sims position a pursestring suture is placed about the anus. An incision is made in the midline extending from the posterior margin of the anus to the sacrococcygeal joint. The coccyx is removed subperiosteally. All bleeding points are clamped and tied. The rectum is freed from the hollow of the sacrum by blunt dissection.

*Stage 2.* With the patient in the lithotomy position, the anus is circumscribed by an incision 2.5 cm. from its midline. The line of cleavage between the prostate or vagina and the bowel is defined, and the bowel pulled taut. The lateral ligaments of the rectum are isolated and incised between clamps. The peritoneal reflection is put on the stretch by gentle traction on the rectum and is pushed cephalad by blunt dissection. If it becomes necessary to open the peritoneal cavity, we never hesitate. All bleeding points are clamped and tied, and the wound thoroughly dried by means of very hot packs.

This procedure leaves the bowel entirely freed from all of its attachments, and the operator may deliver as much of it as is considered necessary. A crushing clamp is applied at the optimum point, above the growth, and the caudad bowel is excised with the cautery. This clamp is now removed and a rather soft rubber tube, 2 cm. in diameter, is inserted into the bowel and

secured with one or two interrupted sutures. The wound is then swabbed with a 10 per cent solution of tannic acid in alcohol, following which the cavity is lightly packed with a roll of 9 inch gauze moistened with the same solution. The rubber tube is cut off at the level of the buttocks. The packing is held in place with a T-binder, and the patient returned to bed.

#### POSTOPERATIVE CARE

Postoperatively the patient is treated as if in shock, since it is much easier to hold a toboggan at the top of the hill than to arrest one in flight. The foot of the bed is raised on blocks, an electric cradle is placed over the patient and a continuous intravenous saline drip is commenced. Morphine and coramine are given as needed. The blocks are removed at the end of twelve hours. The packing is kept moist with the 10 per cent solution of tannic acid in alcohol and is removed at the end of forty-eight or seventy-two hours, replacing it with sufficient gauze, moistened in like manner, to keep the two sides of the wound from touching. Mandelic acid is given as a prophylaxis against urinary infection, but must be administered circumspectly.

The rubber tube ordinarily is found free in the dressings on the fourth day. Failing in this, it should be removed on the fifth postoperative day.

No effort is made to stimulate or retard defecation until the fifth day, at which time if the patient's condition warrants, a dose of castor oil is given by mouth one hour before breakfast. From this point on every effort is made to prevent constipation.

We have followed this routine with our last 15 cases. On the average they were able to get out of bed on the tenth day following operation, and left the hospital during the

third week. So far there has been only one death, and that due to a cardiac condition. We fully realize that this series is insufficient to permit of an estimate as to the true mortality under this technique. Our experience has convinced us, however, that there is less risk attached to the procedure than pertains to any of the others which we have adopted.

#### CONCLUSIONS

Briefly, this modification of the usual technique consists in (1) leaving the wound wide open; (2) excising the bowel at the new level of the peritoneal reflection, with no attempt to anchor the bowel to it; and (3) in dressing the wound with a 10 per cent solution of tannic acid in alcohol. From these changes the following benefits are derived:

1. Leaving the wound wide open eliminates the danger of the formation of pus pockets.

2. The absence of sepsis obviates the danger of secondary hemorrhage.

3. The 10 per cent solution of tannic acid in alcohol forms a coating which is strong enough to prevent saprophytic infections, but is not dense enough to allow virulent organisms to grow under cover of it.

4. Excising the bowel at the new peritoneal reflection lessens the danger of peritonitis and prevents the tendency to prolapse which is so frequently attendant upon this type of operation.

5. This simplification of the technique greatly lessens the operating time.

6. The formation of the tannic albuminate insures a healthy granulating wound and thereby diminishes the period of hospitalization.

7. The final cosmetic result compares very favorably with any operation that has as its object a perineal stoma.





# SIMPLE TECHNIQUE FOR CECOSTOMY\*

R. W. McNEALY, M.D., F.A.C.S. AND MANUEL E. LICHTENSTEIN, M.D., F.A.C.S.

Chief Surgeon, Wesley Memorial Hospital

Associate Surgeon, Cook County Hospital

CHICAGO, ILLINOIS

THE type of colostomy that one makes depends on the indications presented, the conditions under which it must be performed with the idea of facilitating subsequent operative procedures. It has seemed to us that considerable confusion has resulted

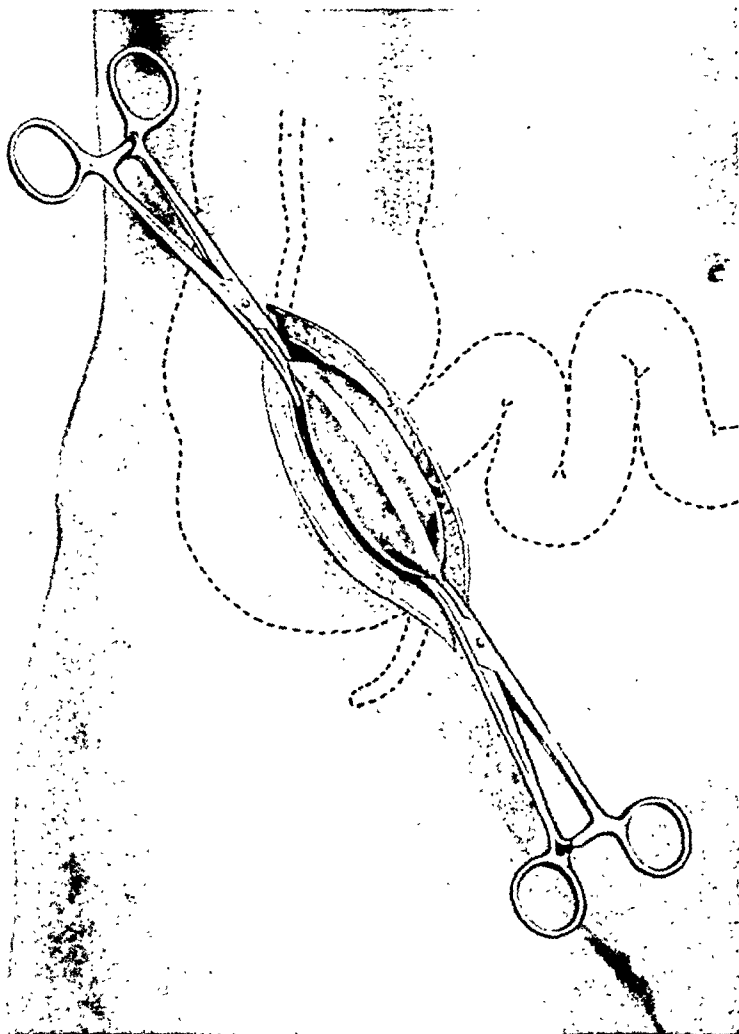


FIG. 1. Portion of cecum isolated and fixed to wound with curved forceps.

be performed and on the anatomical variations of structure which are encountered. In most elective colostomies one has a choice of several fairly standard operations. The majority of these are designed

from the use of the words "permanent" and "temporary" in designating different types of operation.

We prefer to divide them into two principle groups:

\* From the Department of Surgery, Northwestern University Medical School and Cook County Hospital, Chicago.

1. Colostomy in continuity; no spur or interruption in the continuity of the bowel.

2. Complete colostomy; spur present or complete interruption in continuity of bowel.

Colostomy in continuity is indicated when marked distention of the large bowel has occurred and the causative obstruction is so complete that no relief can be obtained through the natural way by any means. The dangers incident to prolonged, increasing distention must be avoided by early relief. The primary consideration is to relieve the distention and prevent further distention. The secondary consideration is to provide a vent through which the fecal current can overflow. No particular attempt is made to divert the fecal stream away from the site of obstruction. It is not uncommon for the obstruction to open after the relief of distention and for the feces to again proceed through the natural channel.

A complete colostomy is one in which the fecal stream is diverted through an opening on the surface. None of the fecal current is permitted to pass into the distal segment of bowel from which the proximal segment is separated. Different means have been employed to prevent this, in some methods the stoma of the distal segment is closed by mechanical means while in other cases it is placed at such a distance as to make it impossible for the feces to find their way into the distal stoma.

The location of the colostomy must be proximal to the site of the obstruction. Thus it may be made in any accessible portion of the large bowel. As a rule, the more distal the site of the stoma and the closer to the obstruction, the more effective it becomes. Where obstruction is present and associated with marked distention, a stoma in the right half of the colon, preferably the cecum, is usually most suitable. The right half of the colon usually has liquid fecal matter and the left half usually has formed fecal matter, the consistency becoming firmer in the descending colon, sigmoid and rectum.

In some cases of marked obstructive distention from lesions of the sigmoid or rectum, it may be desirable to perform a

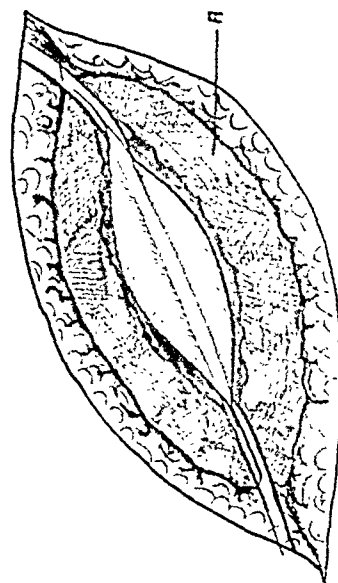


FIG. 2. Isolated portion surrounded by iodoform gauze, A, placed between cecum and parietal peritoneum.

cecostomy for purposes of decompression. Later a left iliac colostomy may be made since it is more desirable as an artificial anus. The cecostomy may be left to close spontaneously or may be closed by operation.

A type of colostomy which has served us very efficiently in a series of difficult cases in which the patients were markedly distended and in whom the intestinal canal could not be decompressed by any of the methods of suction or irrigation will be described. It is also especially useful in the obese individual who is markedly distended and in whom the mesocolon is likely to be very short.

#### TECHNIQUE

Under local infiltration anesthesia the cecum is exposed through a muscle splitting incision similar to that used for appendectomy.

The anterior wall of the cecum is drawn gently through the incision and clamped along the anterior tenia with one or two

curved forceps (Fig. 1). No sutures are used anywhere in the operation.

Between the serosa of the cecum and the parietal peritoneum a strip of iodoform

may be inserted into the lumen of the cecum by introduction through an opening made between the forceps or immediately below the forceps (Fig. 3).

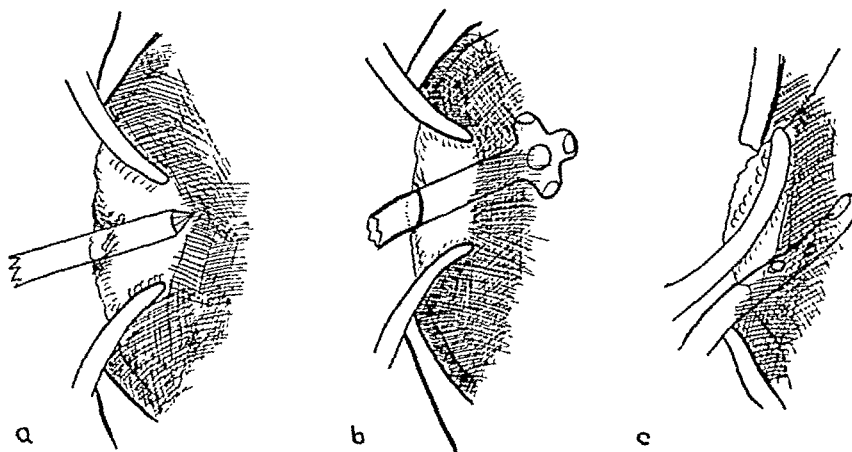


FIG. 3. *a*, trocar introduced after adhesions have formed between cecum and peritoneum, gauze not removed; *b*, Pezzar catheter in place; *c*, when only a small portion of cecum can be isolated and surrounded with gauze, a catheter may be introduced adjacent to the forceps.

gauze is inserted to facilitate the formation of protective adhesions (Fig. 2).

When obstructive distention of the large bowel has been present for a long time, a plastic exudate commonly develops about the cecum which may eventuate in adhesions between the cecum and the adjacent parietal peritoneum. If this has occurred, one may introduce immediately a cannula without danger of contaminating the general peritoneal cavity. In the usual cases the incision is packed open down to the peritoneum and left undisturbed for a period of twelve hours. A catheter then

#### SUMMARY

A method of cecostomy is presented which is simple and permits decompression in a patient who cannot be subjected readily to other more complicated types of operation. We wish to emphasize that this form of colostomy, or cecostomy, is not a substitute for any other method. It is suggested only for that group of cases which appear to be without recourse because of "mountainous" distention or obesity. No claim is made for originality but its proved value urges us to present it.



# SHOCK

## A STUDY OF THE PARTIAL AVAILABLE MODERN LITERATURE OF SHOCK

L. M. BOYERS, M.D.

BERKELEY, CALIFORNIA

ONE is tempted when undertaking a review of the literature of shock to enter his subject rather lightly and with at least as much assurance as he thinks he feels when called to meet its emergency in the surgery. However confident one feels in the early phases of the perusal, it is not long before a slow sense of consternation enters as one is deluged with conflicting theories, and data which refuse to integrate.

In reading the numerous articles one finds that there is no satisfactory account of shock, and he is led to believe that it is still a chaotic field where individuals, committees and commissions wander, while in the hospitals the emergency of shock is met daily in hard practice, now and then successfully. When sufficient time has elapsed, one realizes that a few well supported principles have appeared gradually, which seem well worth our search.

No attempt has been made to make a complete survey of the literature; we have confined ourselves to a review embracing the literature available through a fairly comprehensive list of libraries. We have rarely expressed our own opinions, either those which might be derived from experimental work or those acquired through clinical experience. Both principles and emphasis have been left largely to the actual content of the literature as it exists.

On the completion of this fairly long review specific acknowledgment is made each library mentioned at the end of the paper other than the author's own. This particular acknowledgment is extended also to each author quoted and each publisher mentioned in the reference list. Acknowledgment is also due my secretary, Myra Keplinger, A.B., for her assiduous help in abstracting and collating the materials with which we have dealt.

*Definitions of Shock.* Webster<sup>1</sup> defines shock by the use of words such as "collapse" and "concussion." Roget<sup>2</sup> at greater length uses "attack, paroxysm, seizure, apoplexy, paralysis; thrill, excitement, agitation; concussion, crash, collision, impact; blow, ordeal."

We at once sense in a reconsideration of these terms that the word *shock* has come in the field of medicine to have special significance, one not conveyed usually by such terms as "collapse" or "concussion." It has, in other words, become a technical term and has acquired somewhat exact limits to its meaning.

Dorland<sup>3</sup> describes shock as a

sudden vital depression, due to an injury or emotion which makes an untoward impression upon the nervous system. Shock may be slight and transient, or profound and even fatal. In severe shock the prostration may amount to immobility or syncope; but in other cases the patient is restless and excited. Recovery from shock is followed by more or less quickening of the pulse and respiration and abnormally high temperature.

Schorcher<sup>4</sup> defines shock as

a clinical state resulting from a sudden trauma of the nervous elements influencing the central nervous system by way of the reflex arc. It is accompanied by a rise in the blood pressure followed later by a fall. Collapse, on the other hand, while clinically similar to shock, differs from it causally in that it is the result of a chemical action. It is caused by the absorption of toxic substances and their effect primarily in the circulatory system. It is slower in development and is characterized by a primary fall in the blood pressure.

Rutherford<sup>5</sup> speaks of shock as "an interference with the most fundamental mechanism of life—an interference with

the mechanism for the transformation of energy."

Bickham<sup>6</sup> defines shock as

a reflex depression on the vital functions due to bodily injury, traumatic or operative, due to prolonged operation, or error of anesthetization, due to psychic influence, especially strong mental emotions of a distressing nature, or due to any other cause resulting in the exhaustion of inhibition of the vasomotor mechanism.

According to Wright<sup>7</sup> in his discussion of traumatic shock,

"Shock" is a condition in which the sensory and motor parts of the reflex arc are paralyzed to a greater or less degree, together with a profound disturbance of the circulation, subnormal temperature, and usually frequent shallow breathing; it may be seen typically following severe injuries.

According to Sherrington,<sup>8</sup>

The whole of that depression or suppression of nervous functions which ensues forthwith upon a mechanical injury of some part of the nervous system and is of temporary nature may be conveniently included as "shock." Goltz considered it entirely a collection of inhibition phenomena.

In a dissertation on operative shock Rehn,<sup>9</sup> Professor of Surgery at the University of Freiburg, Germany, says,

All of these considerations have served to contribute to the conception of shock the idea of a sudden occurrence precipitated in one way or another by some factor acting from without and followed by severe circulatory manifestations of a peripheral and central nature together with disturbances of other vegetative centers.

*Definition of Shock Quoted from Early Literature.* In Mann's<sup>10</sup> consideration of "The Peripheral Origin of Surgical Shock," he includes a brief historical review of the subject, quoting early definitions of "shock" by various authors. An example follows: "Travers ('An Inquiry Concerning Irritation,' London, 1826) states that 'shock is a species of functional concussion by which the influence of the brain over the organ of circulation is deranged or suspended.'"

*Analogy between the Chemical Pathology of Cholera and Shock.* With reference to the history of the subject of shock, Atchley and Loeb<sup>11</sup> say "In 1831 Dr. W. B. O'Shaughnessy of Newcastle-upon-Tyne wrote a brief letter to the London Medical Gazette which embodied the results of several years of what he termed his 'experimental inquiries' into the cholera." These authors

have taken time to trace the development of the chemical pathology of cholera because it presents probably the earliest instance in which there was an understanding recognition of the physiologic processes involved in the development of this common complication of many disease conditions, viz., dehydration, salt depletion, and shock. . . .

Chronologically, the next correct appraisal of the fundamental problem may be found in the Guy's Hospital reports of 1874. Dr. C. Hilton Fagge described, therein, "A Case of Diabetic Coma, treated with partial success by the injection of a saline solution into the blood." The most impressive feature of this pioneer experiment in therapy was the rationale which he offered. . . . What suggested to my mind the advisability of injecting a saline solution into the blood in this case was the idea that coma was due to the drain of water from the system, caused by the diabetes. I suppose that the hypothesis upon which I acted was essentially similar to that which formed the basis of the like treatment in the collapse of cholera.

*Characteristics of the Shock Syndrome as Recognized in Modern Surgical Practice.*

Orr<sup>12</sup> states that "James Latta, in 1795, is said to have been the first to use the term 'shock' to describe this condition," referring to a syndrome occurring in surgical practice. Today in the syndrome of surgical or traumatic shock, according to Cannon<sup>13</sup> the following characteristics are recognized, a single case illustrating several or all of them: low venous pressure; low or falling arterial pressure; rapid, thready pulse; diminished blood volume; normal or increased peripheral red cell count and blood hemoglobin; leucocytosis; increased blood nitrogen; reduced blood alkali;

lowered metabolism; subnormal temperature; cold skin, moist with sweat; pallid, grayish or cyanotic appearance; thirst; shallow, rapid respirations; vomiting; restlessness; and anxiety progressing to mental dullness.

*Symptoms and Signs Characterizing Shock Continued.* According to Wright,<sup>7</sup>

Breathing is characterized by long deep sighing respirations alternating with very superficial ones. The patient reacts very slightly and only to very painful stimuli. The limbs are toneless. Spontaneous movements are not made, but in response to urgent orders very brief limited movements may be executed. Complaint may be made of cold, faintness and deadness of all parts of the body.

Marshall and Piney<sup>14</sup> include in their enumeration of symptoms characterizing shock, "profound flaccidity of the muscular system."

Bickham<sup>6</sup> says,

The pulse increases in rate, while decreasing in tension and volume—respiration increases in rapidity and shallowness—temperature is lowered, the pupils dilate . . . and in advanced shock nausea, hiccoughing, and vomiting may occur—incontinence of feces and retention of urine may be present—reflexes are lost—response to stimulation lessens—and coma and death supervene.

Crile<sup>15</sup> says,

. . . whatever the cause of exhaustion (shock) certain basic phenomena are the same— . . . , diminished reserve alkalinity, and in acute phases, increased H-ion concentration of the blood; intracellular changes in the brain, the liver, and the adrenals; decreased electric conduction of the brain and increased electric conductance of the liver.

Moon<sup>16</sup> points out that "shock occurs not only following extensive surgery or trauma. It is seen in a wide variety of clinical conditions including extensive burns, poisoning with various substances, metabolic intoxications, abdominal emergencies, and severe acute infections."

*Consideration of the "Constitutional Condition and Shock."* The original subject

for this paper was "The Constitutional Condition and Shock," which suggests primarily, consideration of the predisposing causes in the physical constitution which militate for or against the state called shock.

Are some body types more susceptible to shock than others? It seems a fertile subject for investigation but very little reference to it is made in the literature dealing with shock.

Crile<sup>17</sup> says in his lecture delivered before the Harvey Society in January, 1908, "It is axiomatic to state that the better the physical condition the less the shock."

*Factors Predisposing to Shock.* Rutherford,<sup>5</sup> discussing the significance and management of shock, lists the following predisposing causes of shock:

1. *Age:* The aged do not endure shock well. The risk is determined, not by the age of the patient but by the age of his circulatory apparatus. When aged patients are subjected to injury, the immediate circulation and other changes may be slight; but, under these conditions, the power of compensation or rebound is likely to be equally slight.

Mortimer<sup>18</sup> says with regard to the relationship of age to shock:

Shock is more likely to occur in infants and young children than in adults, for the whole nervous system is more responsive to impressions, and diffusion of these readily occurs, as is found in the liability of infants to general convulsions from causes which do not have the same effects later in life . . .

Rutherford continues as follows:

II. *Sex:* Before puberty there is little or no difference in the susceptibility of the sexes. After puberty, especially after the menstrual period (begins), the female becomes less stable. The male grows more hardy. During the child-bearing period the female develops an increased capacity for shock. During the menopause the female again becomes more susceptible to shock. After the period of developing menopause the female has entered upon an unbroken period of quietness and her resistance is increased. At the corresponding age, the male is carrying the greatest burden of his career,

and from this period on to the end he is not so good a surgical risk as is a woman.

III. *Time of Day:* There is a marked daily variation in the process of metabolism of the body, beginning in the morning and ending in the evening. The vital processes are more active, reserved forces are at a maximum, the psychic factor at a minimum on rising in the morning. The most unfavorable time is from one to two o'clock in the morning. Night accidents are likely to be more grave than equally severe ones occurring during the day. In lingering illnesses, more deaths occur after midnight than during the day.

Wakeley and Buxton<sup>19</sup> mention race in addition to age, sex, and time of day: "Race is of some importance; the colored races are not so easily shocked as the white races." These authors say also, "Nervous patients are notoriously bad subjects for operation. So-called 'psychic shock' may supervene in a patient anxious about an operation. This shock may even come on during the operation while the patient is still unconscious, and it certainly tends to be a real danger afterwards."

Among additional factors predisposing to shock Robertson<sup>20</sup> mentions the fact that "Injury to the liver by chloroform or phosphorus greatly reduces the power of an animal to withstand depletion of its plasma proteins."

Crile<sup>15</sup> says,

We have found that exhaustion may be produced by an excess of, no less than by the want of thyroid or adrenal or brain activity. We have found that loss of liver function, want of oxygen, want of cardiac power, want of normal vasomotor action, of themselves, individually or in any combination, may predispose to or cause exhaustion (shock).

Wangensteen<sup>21</sup> includes "anemia, infection, malignancy, inanition, fever, obesity," as some of the conditions that predispose toward shock.

*Varieties of Shock.* There are several varieties of shock, depending upon the agents giving rise to the syndrome, and also upon the sequence of events in the

subject exhibiting the phenomena. One has consequently:

1. Physical shock;
2. Chemical shock;
3. Electric shock;
4. Mental or psychic shock;
5. Shell shock;
6. Litigation "shock."

1. *Physical Shock.* Wound shock, surgical shock, and traumatic shock are examples of physical shock. Pleural shock, discussed, for example, by Hamilton and Rothstein<sup>22</sup> and also by Cocke<sup>23</sup> is to be mentioned as a subheading under traumatic shock. Hamilton and Rothstein define pleural shock thus: "Pleural shock (pleural reflex, pleural eclampsia, pleural epilepsy) is a syndrome caused by irritation or puncture of the pleura and is characterized by the appearance of a group of symptoms not unlike those of air embolism."

Obstetric shock, also, is a form of traumatic shock under the general heading of physical shock. Taylor,<sup>24</sup> discussing this form of shock, says "It is my growing belief that separation of the placenta, in whole or in part, is rapidly followed by the formation of histamine or allied substances . . . then a major fall of blood pressure takes place. This fall has Nature's desired effect of stopping further hemorrhage on a large scale. . . ."

Shock due to freezing is a form of physical shock, although the results of severe freezing which contribute to the shock state have been shown by Harkins<sup>25</sup> to be similar to those following severe burns which will be mentioned under chemical shock.

"Speed" shock is another variety of physical shock. It is the syndrome which has been described as resulting from rapid intravenous injections. Milbert,<sup>26</sup> quoting Hyman et al., says that these workers "are of the belief that a rapid injection of any molecule into the vein may result in widespread systemic disturbances . . ." Milbert's own conclusions, however, are "That the role of velocity does not play a clinically

perceptible part in administering fluids intravenously."

2. *Chemical shock* includes anaphylactic shock, insulin shock, colloid shock, etc.; but also, no doubt, is related in many of its ramifications to physical shock. Shock following severe burns may also be classified as chemical shock. Harkins,<sup>27</sup> considering experimental burns, writes in summary:

... local accumulation of fluid in cases of burns . . . begins at the time of the burn and continues in the form of a decelerating curve until death. Accompanying the collection of fluid is a simultaneous increase in the concentration of blood as shown by an increase in the percentage of hemoglobin and in the hematocrit readings. After most of the fluid has accumulated, the fall in blood pressure sets in and continues rapidly until death occurs in a state of secondary shock.

Chemical shock is also probably related in many of its ramifications to the third division, i.e.,

3. *Electric Shock*. This variety of shock may easily be related immediately or remotely to both physical shock and chemical shock. According to Palfrey,<sup>28</sup> "The effect of electric shock is predominantly a paralysis of respiration." Among Pearl's<sup>29</sup> conclusions we find the following:

(3) It is probable that death from electricity in higher animals is due, in a majority of cases, to primary fibrillation of the ventricles. In man this condition is hopeless unless prompt and heroic treatment is instituted. (4) Post-mortem findings fail to explain the cause of electric death. Changes in the walls of the vessels are noteworthy. Heat rather than electrolysis is probably responsible for most pathologic changes . . . (10) The sequelae of electric shock are many and varied. The most important ones affect the skeletal and nervous systems.

4. *Mental or Psychic Shock*. "Psychic shock," says Mortimer,<sup>18</sup> "has been defined as the effect on the medullary centres of impulses from the centres of consciousness (pain, fear, and other emotions)." This type of shock obviously is or may be present in some degree in physical, chemi-

cal, and electrical shock, and may derive some of its reinforcements from any combination of them. It may, on the other hand occur spontaneously from purely psychic causes and then run off into phenomena identifiable as having physical, chemical, and electrical shock characteristics.

5. *Shell Shock*. This term, says Wiggers,<sup>30</sup> "is reserved in the literature for more distinctly nervous disturbances which more or less permanently disqualify the patient but do not lead to circulatory failure and death."

6. *Litigation "shock"* is a condition, says Fraser<sup>31</sup> (quoting McKendrick) which is incapable of medical definition or of proof or disproof. True shock is the result of excessive pain, of severe bodily damage or due to some very terrifying experience. Litigation or "nervous shock" as it is often termed, on the other hand is a condition that is not suddenly produced but has a gradual onset.

Somewhat obscurely, in a statement having possibly more legal than medical value, we read that Spilsbury<sup>32</sup> regards "'shock' . . . as one of the most over-worked terms in the medico-legal vocabulary, as many deaths said to be due to shock should really be ascribed to such conditions as loss of blood, exhaustion, injury to a vital organ or concussion of the brain, etc."

According to its behavior in the animal organism, surgical shock is divided into two stages:

Primary shock is

very frequently seen in those cases in which injury has been so severe that death is inevitable, or may quickly supervene, unless proper treatment is instituted at once. The symptoms of *primary* shock develop as soon as the wound is received, with the onset of pallor, profuse perspiration, chilly sensations and sometimes loss of consciousness. The pulse rate is increased, but the blood pressure reading may early be somewhat increased or normal.<sup>12</sup>

Cannon<sup>13</sup> observes that "*Primary* shock may be seen . . . either in the mortally



wounded, or after extensive hemorrhage, or in the relatively rare instances in which nervous elements seem to play an important role."

According to Mann and Essex,<sup>33</sup>

There seems to be complete agreement that the primary feature, whether the shock is immediate or delayed, is low arterial blood pressure. In either type of shock, if a low blood pressure persists for an hour or more, the secondary condition appears and is attended by the phenomena associated with oxygen lack, such as decreased metabolic rate, and decreased alkaline reserve.

Speaking of primary shock, Friedlander<sup>34</sup> remarks that "it is altogether probable that as a consequence of wounding, there is a reflex relaxation of blood vessels similar to that which occurs in fainting." Wright<sup>7</sup> states that, "Early or primary shock, which sets in immediately following an injury . . . is probably due to afferent impulses causing reflex vasodilation and a profound fall of blood pressure."

*Primary and Secondary Shock.* "Recovery from primary shock may be quite prompt or it may develop into the secondary type."<sup>12</sup>

Wright<sup>7</sup> says secondary shock is "due chiefly to a capillary poison, probably histamine or some substance with a similar action which is liberated from the injured tissues."

Cannon<sup>13</sup> in this regard says: "The theory of a secondary shock which has the strongest support . . . is that of a toxic factor operating to cause an increased permeability of the capillary walls and a consequent reduction of blood volume by escape of plasma into the tissues."

In quoting Quenu, "who has also collected and summarized the studies of other French surgeons made during the war," Friedlander<sup>34</sup> says, "Secondary shock does not appear immediately after the reception of wounds. So that it is not of the nature of a nervous effect. The state is commonly well established before infection, and therefore is not of bacterial origin."

Cannon<sup>13</sup> says further:

Exposure to cold, lack of water, rough carriage and absence of splinting of broken bone have been recognized as circumstances favorable to the onset of the symptoms. A still later aspect of secondary shock is that which is attended by infection, especially with gas bacilli.

Orr<sup>12</sup> says, "Secondary wound shock is the type usually encountered in the severely wounded. It is also the type frequently seen following serious or prolonged surgical operations."

*Primary and Secondary Forms of Shock Distinguished.* Holt,<sup>35</sup> opening a discussion on traumatic shock at a recent meeting of the Section of Surgery of the Royal Society of Medicine, compared circulatory changes in neurogenic (primary) shock and traumatic (secondary) shock thus:

| Secondary Shock<br>(Hematogenic)       | Primary Shock<br>(Neurogenic)  |
|--|--|
| Blood pressure maintained.             | Fall of arterial pressure.   |
| Rise in pulse rate.                    | No rise in pulse rate.   |
| Vasoconstriction.                      | Vasodilation.  |
| Diminution in blood volume.            | Blood volume not diminished.   |
| O <sub>2</sub> consumption diminished. | No change in O <sub>2</sub> consumption.                                     |
| Fall in blood pressure serious.        | Fall in blood pressure not serious so long as respiratory center maintained. |

*New Descriptive Terms Suggested to Replace "Primary" and "Secondary" as Applied to Shock.* He thought

. . . that some other classification than the division of shock into *primary* and *secondary* was necessary. American writers had suggested the following classification: *hematogenic*, resulting from loss of circulating blood volume (muscle trauma); *neurogenic*, resulting from loss of central vascular tone (trivial injury, emotional distress); *vasogenic*, resulting from loss of peripheral vascular tone (histamine and other drug reactions). The adoption of some such classification would do much to remove the present confusion in which the pathology of this subject had been placed.<sup>35</sup>

*Is There Such a Condition as "Secondary" Shock?* At the same meeting at which these recommendations were made, it is noted that O'Shaughnessy declared "he had never seen a case of secondary shock nor read a satisfactory account of such a case, nor seen it experimentally produced." According to his experience, "following trauma the syndrome progressed either to recovery or to a fatal end. There was never an initial recovery followed by a later onset of shock."

#### OPINIONS REGARDING CAUSATION OF SHOCK

1. *Accumulation of Blood in the Capillaries.* Crile<sup>15</sup> uses the term "shock" to denote a state of exhaustion which has been developed rapidly by psychic, traumatic, toxic or thermal stimuli. Hewlett,<sup>36</sup> in resumé, says

The marked hypotension of surgical and traumatic shock is not due in the main to a loss of arterial tone or to a failure on the part of the heart. It is due to a lessened flow of blood to the right auricle, caused mainly by an accumulation of blood in the smaller venules and capillaries. This accumulation may be due to a direct injury of the part or it may be caused by vascular poisons absorbed from the damaged tissues. There is no good evidence that nerve lesions play a dominant role in the pathogenesis of the more serious forms of surgical or traumatic shock.

2. *Loss of CO<sub>2</sub> from the Blood.* In discussing the causation of shock, McDowall<sup>37</sup> says,

Of special importance in relation to central failure as a cause of surgical shock is undoubtedly sensory stimulation. . . .

The real explanation has . . . been shown by Yandell Henderson to be due to the washing-out of carbon dioxide brought about by the hyperpnoea occasioned by the sensory stimulation. The acapnia or loss of carbon dioxide . . . brings about a reduction in the tone of the vaso-motor centre . . . In such anesthesia (light ether), as pointed out by Henderson, it is important to remember that apart from the fall in blood pressure, there may be brought about death from failure of respiration as a

result of the washing-out of the normal stimulus—carbon dioxide. The amount of this gas in the blood becomes insufficient to stimulate the partly anesthetized centre and respiration becomes inadequate to supply the oxygen requirement of the body, especially of the heart and the medulla.

3. *Role of Anesthesia as a Causative Factor in Shock.* Statements by Knoefel<sup>38</sup> with reference to the role of anesthesia as a cause of shock may be quoted here. He says in part:

. . . the secondary or delayed shock that may be produced by prolonged anesthesia with ether or chloroform is due to a concentration and reduction in volume of the circulating blood resulting from general stimulation of the sympathetic nervous system including the outpouring of adrenin . . . Banerji and Reid have just shown that in the hyperglycemia caused by ether and chloroform, the adrenals are importantly concerned, and have again demonstrated that such production of hyperglycemia is inhibited by amytal.

Does amytal, with related substances prevent the general hyperactivity of the sympathetic nervous system that ether and chloroform produce? If they do, and there is some evidence for such a conclusion, then their use as basal narcotics receives important support in that the tendency of such volatile anesthetics to produce shock may be markedly counteracted.

*Local Nerve Block in Shock Prophylaxis.* The utility of local nerve block in prophylaxis of shock is mentioned by certain workers. Jones<sup>39</sup> declares that "Local nerve block with a cocaine derivative (nupercain) lessens damage to the central nervous system, allows relaxation with a minimal anesthesia, and prolonged freedom from pain in the postoperative period."

4. *Precipitation of Particles in Capillaries, Lymphatics, etc.* McDonagh<sup>40</sup> makes the following assertion:

Shock is due to the precipitation of the protein particles of the plasma in the perivascular lymphatics, capillaries, and occasionally the arterioles of an important viscus. The particles are precipitated because they have become too large or too agglutinated to

circulate, therefore any agent that can cause these two physical changes to occur in excess may produce shock. The chemico-physical changes the protein particles in the plasma undergo to cause disease, are the same whether they be caused by a parasitic or a chemical invasion . . . When protein particles are dispersed the particles become smaller, more numerous, their Brownian movements increase, and their negative electric charge becomes more pronounced. Excessive dispersion results in intra-vascular clotting and causes one of the forms of shock. Experimentally, this form of shock is occasioned best by an overdose of para-thyroid extract.<sup>40</sup>

### THEORIES OF SHOCK

The following theories of shock are those having support of the majority of investigators dealing with the subject:

#### 1. "Acapnia" (Henderson).<sup>41</sup>

The fundamental condition (in the development of shock) is a disturbance of the respiratory metabolism of the tissues which leads, through processes which are still obscure, to the acapnia state. That this state may properly be defined as acapnia is proved by the fact that, given an adequate oxygen supply and a restoration of the hemoglobin to transport it, no other known procedure brings all the functions of the body back to their normal state so effectively and so rapidly as does inhalation of carbon dioxide.

2. "Acidosis," or hydrogen-ion increase in the blood. Cannon<sup>13</sup> says of the "acidotic" process: "Non-respirable acid, such as lactic acid, develops in the tissues because of oxygen-want and, uniting with the  $\text{Na}_2$  of  $\text{Na}_2\text{CO}_3$ , drives off  $\text{CO}_2$  which is breathed out."

3. "Adrenal." Theories on the basis of an "adrenal" factor are apparently poorly supported. "Neither the suggestion of overactivity nor the suggestion of underactivity of the adrenals has sufficient evidence in its favor to warrant attributing shock to the adrenal glands," according to Cannon.<sup>13</sup> Wiggers<sup>30</sup> more recently has expressed a like opinion. Conclusions of other investigators who have experimented with animals

with and without adrenal glands in a shocked state are quoted below.<sup>86-88, etc.</sup>

4. "Capillary congestion." Blalock<sup>42</sup> says of this theory: "Starling . . . thought the lost blood (in shock) was mainly in the capillaries of skeletal muscles . . .

"Erlanger and his associates . . . noted (in experimental shock) that the capillaries and venules of the intestinal villi were distended with solid masses of red corpuscles."

5. "Fat embolism." Quoting Moynihan,<sup>43</sup>

The presence of fat emboli in the lungs and other viscera of patients dying with all the symptoms of acute surgical shock has been reported by Bissell (1917), who also remarked upon the large amount of fat in the venous blood of such patients, as well as in the blood of patients with broken bones. The frequency of shock in the wounded among patients with broken bones, or with multiple wounds of the soft parts, was also pointed out by Porter (1916) (and also by Porter<sup>44</sup> in 1920) as evidence of the part played by fat embolism in the production of shock.

6. "Inhibition." Blalock<sup>42</sup> says of this theory:

It was developed by Meltzer before the reduction of the blood volume in shock was recognized. He noted that dissection of the skin of the abdomen caused an inhibition of peristalsis. . . . However, as Cannon has emphasized, the cessation of intestinal movements is not due to the inhibition of activity in the central nervous system, but rather to activity there.

7. "Local vessel injury with local loss of fluid." This theory is mentioned by Blalock,<sup>42</sup> who says,

Many different types of experiments have been performed and the results indicate that the loss of blood at the site of injury and not the absorption of toxins is responsible for the diminution in the blood volume and the decline in blood pressure following trauma to an extremity.

8. "Traumatic toxemia."

The present outlook, Cannon<sup>13</sup> says, seems to be that not only the shock following burns,

but also the shock consequent on severe trauma, is properly in the same category with other forms of general depression of bodily functions and defective circulation due to the setting free of toxic material in the body, and that the nervous factors, which for so long a time have been regarded as of primary importance, should be relegated in most cases to a secondary position.

9. "Vasoconstriction." Cannon's<sup>13</sup> criticism of this theory is as follows: "The chief defect in the argument (in favor of vasoconstriction as a cause of shock) lies in a failure to account for a primary vasoconstriction capable of inducing the effects which Malcolm<sup>62</sup> describes."

10. "Vasomotor exhaustion." Crile<sup>15</sup> says,

We have found that excessive emotion, exertion, injury, infection, loss of sleep, hemorrhage, or the injection of acids, alike may cause exhaustion; and that, whatever the cause of exhaustion certain basic phenomena are the same—muscular and mental weakness; diminished adaptive metabolism; increased respiration; increased pulse rate; sweating; diminished reserve alkalinity and in acute phases, increased H-ion concentration of the blood; intra-cellular changes in the brain, the liver, and the adrenals; decreased electric conductance of the brain and increased electric conductance of the liver.

*Medical Shock.* Atchley<sup>45</sup> emphasizes the

importance of shock as a fairly frequent and very vital complication of certain *medical* conditions. It can be seen that the internist may find two types of shock. There is *anhydremic* shock, dependent on simple loss of blood volume, an example of which is diabetic coma; and there is *toxemic* shock, dependent on possible capillary paralysis from some bacterial or protein substance, an example of which is vasomotor collapse in pneumonia.

This author<sup>45</sup> reports the case of an intravenous rattlesnake bite with subsequent shock and eventual recovery.

Moon and Crawford<sup>46</sup> report the case of a man exhibiting the shock syndrome in mercuric chloride poisoning.

Muller, Myers, et al.<sup>47</sup> describe shock symptoms which occasionally follow "the intravenous injection of arsphenamine and other drugs or serums."

*Fatal Shock Following Intracutaneous Test with Horse Serum.* Freedman,<sup>48</sup> in reporting a fatal case of acute anaphylactic shock following intracutaneous test for sensitivity to horse serum, reviews the literature of related fatalities. In his opinion "Fatal reactions following the subcutaneous, intramuscular or intravenous injection of horse serum comprise the largest group of such anaphylactic deaths. Fatal reactions following the intracutaneous injection of a protein, however, are extremely rare."

*Gas Bacillus and Shock.* Buerger<sup>49</sup> points out a practical point in that, "The early local signs of gas bacillus infection when deep seated may be mistaken for local shock, all the more so since the limbs, already in the condition of local shock, were found especially prone to this type of bacterial invader."

*Further Observations Regarding Traumatic Toxemia.* Number 8 of the theories of shock causation, i.e., that of "Traumatic Toxemia," may be elaborated somewhat. It is significant that surgeons who served on the battle front during the Great War observed that some toxic agent very definitely played a part in so-called "shock" cases. Thus in the special report of the Medical Research Committee, Dale, Laidlaw, and Richards<sup>50</sup> make the following statements:

Shock, as produced by histamine, seemed to us . . . to be a condition in which the circulation failed, and the arterial pressure fell to a low level, in spite of arterial constriction, because the blood drained away into the capillary network and tended to stagnate there, instead of returning to the heart through the veins. And in seeking for an explanation of this condition it seemed to us that, while loss of plasma and consequent thickening of the blood, when they occurred, would accentuate the tendency of the blood thus to accumulate at the periphery, the essential cause must be a general loss of the normal tone of the

capillary walls. All observations on the living circulation supports the idea that only a small part of the capillary network is at any one moment functioning as a channel for the blood.

*Histamine Shock.* . . . An investigation carried out by two of us<sup>50</sup> (Dale and Richards, 1918) . . . furnished us with positive evidence in favor of the view that histamine, and by implication the group of substances having the same type of action, owe their effect on the circulation, whether the evanescent depressor effect of small doses or the shock-like effect of large doses, to their power of obliterating the normal tone of the capillaries.

Over against this factual data we read reports exemplified by the following excerpts: Miller,<sup>51</sup> of Los Angeles, observes that "the classically accepted theory that the production of histamin in the tissues by trauma increases capillary permeability, permitting the escape of fluid from the vascular bed is now being questioned." He quotes results obtained by Freed<sup>51a</sup> who "has shown that rats which are very resistant to histamin, are not shocked by extensive trauma unless they have been previously adrenalectomized."

"Vicious Circle" of Causal Events in Production of Shock. Miller<sup>51</sup> considers the causal sequences of events in shock to be as follows:

Dehydration produces increased viscosity of the blood which in turn produces anoxemia, already shown to give sympathetic stimulation. Sympathetic stimulation results in increased secretion of epinephrin, which increases the rate of the denervated heart; thus demonstrating that dehydration produces sympathetic stimulation. (Note former quotation concerning sympathetic stimulation by ether and chloroform—Knoefel.<sup>38</sup>) In shock the vicious circle is completed by the observation that prolonged sympathetic hyperactivity producing vasoconstriction reduces blood flow in large areas of the body, resulting in anoxemia and increased permeability of the smaller blood vessels with the loss of proteins and fluid.

We find Wright<sup>7</sup> quoting Cannon, and observing:

(i) Histamine is present in all tissues and is readily liberated as a result of even trivial injuries. (ii) Many of the features of surgical shock are identical with those of histamine poisoning, e.g., the low venous return, the diminished cardiac output, the low blood pressure, the rapid pulse, the diminished blood volume, the increased viscosity of the blood and the rise in the haemoglobin percentage, visible distension of the minute vessels in the bowel and the increase in the weight of intestinal loops.

Injuries which liberate quite small quantities of this capillary poison may induce shock in the presence of (a) an anesthetic which sensitizes the blood vessels to the action of histamine, (b) other complicating factors which of themselves tend to lower the blood pressure, e.g. (i) exposure to cold; (ii) lack of food and water . . . ; (iii) considerable sweating which for some unknown reason often accompanies severe injuries, causes further loss of fluid, and also tends to lower the body temperature; (iv) hemorrhage by itself, even if twenty-five per cent of the blood volume is lost, does not give rise to a permanent fall of blood pressure, but hemorrhage combined with injury produces shock.

*Histamine-like Tissue Extract Called by Various Names.* For many years numerous investigators believed that histamine or a histamine-like substance released in the blood stream has been an accompaniment of, and a causative factor in the production of (secondary) shock. We find in the literature different terms referring to this toxic tissue product. In the accounts of his researches Turck<sup>52</sup> has given the name "cytost" to the tissue extract derived from injured tissues. De Nito,<sup>53</sup> discussing blood pressure reducing hormones and protein shock, designates "lymphoganglin" which is believed by him to be formed in the lymph nodes as the most important "hormone" of this kind.

*In Defense of the Role of Histamin Substance in Shock Production.* Clark<sup>54</sup> says in his concluding paragraph of an article on surgical shock,

Although it would now appear as a result of recent work that loss of fluid from and into the

injured area and not histamine is the cause of shock, it would be as well to remember, as Dale (1933) puts it, that "we should be unwise on the ground of negative results of experiments on the crushing of the histamine-poor voluntary muscles to discount altogether the possibility that irritative handling and exposure of abdominal viscera, for example, which are relatively rich in it, might liberate histamine into the circulation in shock-producing amounts."

*Traumatic vs. Histamin Shock.* Holt<sup>35</sup> believes

No observer has satisfactorily demonstrated the presence of any depressor substance in the venous blood from a traumatized area; . . . The circulatory changes of traumatic shock differ considerably from those produced by the injection of histamine or other depressor substances obtained from tissue extracts. Marked differences were found in the changes which followed traumatic and histamine shock respectively. The changes indicated . . . are best set out in the following tabular form:

| Traumatic Shock  | Histamine Shock   |
|--|---|
| Diminished circulating blood volume.                             | No marked change in blood volume.   |
| Diminished output of heart before arterial blood pressure falls. | Decline in arterial blood pressure before any diminution in cardiac output. |
| Removal of small quantity of blood causes death.                 | Much larger quantity of blood must be removed to cause death.               |
| Marked pallor of viscera.  | Congested appearance of viscera.  |
| Lungs pale and heart containing very little blood.               | Lungs congested and heart well filled with blood.                           |
| Very little blood when solid viscera sectioned.                  | Solid organs bleeding freely on section.                                    |

*Experimental Surgery on Animals Tells Less than the Whole Truth When Applied to Human Beings.* O'Shaughnessy and Slome,<sup>55</sup> discussing etiology of shock on the basis of experimental work, declare that "our first conclusion is that a toxemia due to the elaboration of histamine, or any other depressor substance manufactured in the traumatized area, plays no part in the

syndrome of traumatic shock." Speaking of the variance of results of the experimental work of these investigators and that of Cannon, Miller<sup>56</sup> says, "As is so often the case, experimental surgery on animals tells less than the whole truth when applied to human beings, for in this instance it can take no account of that most important human factor, the psychological attitude of the patient."

Roome and Wilson<sup>57</sup> also record results of experimental work which lead to the conclusion that "The findings do not support the 'toxic theory' of the etiology of traumatic shock."

*Injury of Certain Parts of the Body Causes Shock More Readily than Injury of Other Parts.* With regard to traumatic shock, Wangensteen<sup>21</sup> asserts that shock follows injury of certain parts of the body more readily than others:

Fractures of the lower extremities, especially if accompanied by considerable bruising of the muscles, are very likely to be accompanied by shock. . . . Fractures of the lower extremity are more frequently followed by shock than similar injuries in the upper, accounted for largely by the presence of larger muscles in the lower extremity giving rise to more bleeding when injured. Fractures of the femur and pelvis are frequently attended by shock.

Head injuries, unless accompanied by a good deal of external hemorrhage, rarely give rise to shock. Fractures of the skull, unless associated with intraventricular hemorrhage or injury of the medullary centers, rarely give rise to depression of blood pressure or shock. . . . Isolated fractures of the spine rarely produce shock. And in a patient with a fracture of the spinal column presenting shock, concomitant injuries elsewhere such as intraperitoneal damage or a broken femur, should be looked for. (Italics ours.)

Wounds of the thorax in which multiple fractures of ribs occur may give rise to shock, owing to the formation of numerous hematomas. Severe shock may also follow the fracture of a single rib, in which the lung is punctured with the accumulation of blood in the pleural cavity. . . .

*Intraperitoneal Injury and Shock.*<sup>21</sup> Intraperitoneal injury, unless accompanied by severe

hemorrhage, does not give rise to significant depression of blood pressure. Contrary to general belief, the perforation of a hollow intraperitoneal viscus is not followed by shock with immediate reduction of arterial pressure. Collapse and disability, however, are the rule, owing to the pain produced by irritation of the parietal peritoneum.

*Condition of Blood Vessels in Shock.* With regard to the state of blood vessels in shock there is difference of opinion as to whether the vessels are dilated or constricted. Friedlander<sup>34</sup> declares that "the fall in blood pressure is due to dilatation (and congestion) of the large venous trunks of the splanchnic area with coincident medullary anemia." On the other hand Orr<sup>12</sup> says that "Wallace, Fraser, and Drummond, after operating upon many hundreds of patients with abdominal injuries in all degrees of traumatic shock, have not found any splanchnic congestion to exist."

Parsons and Phemister,<sup>58</sup> discussing experimental results, say, "We necropsied dogs which died as a result of traumatism of the extremities and found no dilatation or engorgement of the blood vessels of the intestines and other abdominal viscera. On the contrary the intestines were pale."

Hewlett's<sup>36</sup> conclusions regarding the mechanical factors which lead to the low arterial pressure of shock are that "although some reduction in arterial resistance and in cardiac efficiency may be present, the chief cause of the hypotension is withdrawal of blood from the circulation partly through the passage of plasma into the tissues but mainly through stasis of blood in capillaries and small veins." Buerger<sup>49</sup> quotes Dale, Cannon, and Hooker, who account for fall of blood pressure in shock as "due to the fact that capillaries become paralyzed and dilated with stagnation within them, thus rendering the arteriole contractions ineffective."

Blalock<sup>59</sup> says,

The initial changes in blood pressure (in shock) are to be considered as secondary to (1) compensatory vasoconstriction, and (2) dimin-

ished output per beat. The minute output is usually diminished, but in those experiments in which tachycardia develops early the minute output may remain normal while the initial changes in blood pressure occur.

Cutler and Scott,<sup>60</sup> without reference to dilatation or contraction of vessels, say,

It now seems clear that shock is but a symptom complex resulting from a rapid diminution in the circulating blood volume below the point of circulatory efficiency. When a certain point (the critical level) is reached, the low blood pressure and insufficient supply of blood acts in a vicious circle as an added injury to the capillary bed.

Rost<sup>61</sup> remarks that

investigations of Mauthner and Pick have shown (that) there is a constriction of the blood vessels both of the liver and the intestines. During the contraction of the liver capillaries, the venous blood in the intestinal vessels is choked back. A constriction also occurs in the capillaries of the lungs. The blood pressure falls because the heart receives nothing to pump.

. . . According to the opinion of Crile and Mummery the blood pressure sinks because of paralysis of the vasomotor center. But numerous investigations of other writers, such as Malcolm, Seelig and Lyon, Mann, have shown that the blood vessels in shock are not dilated but constricted.

Malcolm,<sup>62</sup> in setting forth his views as opposed to those of Crile in the matter of the condition of blood vessels during shock, declares:

Crile's conclusion requires further proof . . . because the assertion . . . that a lowering of blood pressure in the carotids must depend on a relaxation of some part of the vascular system is open to question. It is, in my opinion, an altogether untenable proposition. It appears to be founded on the idea that a contraction of the arteries causes a rise of blood pressure and a relaxation causes a fall. But this is a very incomplete and inexact statement of the well recognized law that the small arteries exercise a regulating or stopcock action on the flow of blood to the tissues. When fully set forth an essential part of the

stopcock mechanism is that a contraction raises the pressure in the large vessels, but at the same time lowers the pressure in the smaller ones, in those beyond the point where the stopcock is supposed to act. Hence, if any vessel has its lumen sufficiently contracted, the blood pressure in it will be lowered. I believe that in this fact we have the true explanation of the fall of blood pressure in shock.

McDowall<sup>57</sup> says,

When the shock is due to capillary dilation as a result of toxins, the arteries are undoubtedly constricted, as has been emphasized by Malcolm. This has indeed been shown experimentally by the writer and may be taken as evidence of an attempt at compensation, such as we know occurs in hemorrhage.

According to Parsons and Phemister,<sup>58</sup>

Handy and Phemister found that re-injection or circulation by means of a vivi-perfusion apparatus of several cubic centimeters of slightly traumatized or slightly haemolyzed blood in the femoral artery caused vasodilation in the limb of a dog, but that these same amounts of severely traumatized or completely haemolyzed blood caused vasoconstriction when circulated in the limb. We have tested this further by the injection of completely haemolyzed or severely traumatized blood in small quantities (1–50 c.c.) into the left heart or first portion of the aorta, so that it reaches the general capillary bed in high dilution. It produces a sharp decline in blood pressure which with 25–50 c.c. may be as much as 70 mm. of mercury. But the recovery was always very prompt (one-half to two minutes) and when it was injected more gradually the blood pressure would return to the previous level before the injection was completed. . . . It seems that passage of the damaged blood through the lung capillaries robs it very largely of its vasodilator property, and passage through the capillaries of a limb completely destroys it.

The cause of the vasodilation is unknown. It was thought that it might be due to a histamine-like substance liberated from the broken down cells, but this is not so, since, when the amount of histamine injected into an animal is increased, the fall in blood pressure becomes more marked and prolonged,

whereas very large amounts of extensively haemolyzed or severely traumatized blood (200–400 c.c.) circulated through a peripheral artery do not lower general blood pressure at all and when circulated through a vein produce only an initial fall for one to two minutes. This paradoxical behavior when varying concentrations and amounts of damaged bloods are injected may be due in part or whole to physical chemical changes, not to a toxin acting on the cells.

*The Cause of Experimental Vasodilation Is Unknown.* According to Wakeley and Buxton,<sup>19</sup>

In shock the lips are pale, and the skin is cold, a state of affairs not at all suggestive of dilatation of the surface capillaries. The splanchnic area is quite large enough to accommodate a great deal of blood. Experimental production of splanchnic dilatation results in a fall of blood pressure. In shock, however, the practical observations of the surgeon show that no such dilatation occurs.

*The Blood Vessels in the Intestinal Tract in Shock.* The intestines are pale in shock, and not red and engorged as would be the case with splanchnic dilatation. The capillaries of the muscles are under different conditions from the capillaries of the viscera and skin. Their activity is dependent on the state of the muscle, and it is possible that the loss of tone in the muscles in shock allows of passive dilatation of a large mass of capillaries.<sup>19</sup>

Petroff, Filatov, et al.<sup>63</sup> conducted experiments with volume determinations of kidneys, spleen, hind legs, and brain which

indicate that the introduction of hemolyzed or foreign blood causes a marked narrowing in the lumen of the renal and splenic blood vessels. The circulation in the brain and in the hind legs was affected only slightly. . . . These experiments demonstrated that the main alterations in the circulatory system in hemolytic shock proceed from the alterations in the walls of the arteries and the veins.

Wesselkin et al.<sup>64</sup> "have been able to substantiate the basic experiments of Hesse and Filatov as to the spasm of the renal arteries constituting a characteristic symptom of the acute stage of shock."



*Deoxygenation of Body Tissues in Shock.* MacFee and Baldrige<sup>65</sup> say,

the essential fact of shock is deoxygenation of body tissues, occurring from impairment of circulation . . . (which) results from diminution of blood volume in circulation. This loss is due to stagnation of blood in the capillary areas and to escape of plasma from capillary channels. Hemorrhage and dehydration are frequent factors.

*Blood Cell Counts in Shock.* Cannon<sup>13</sup> and his co-workers at Bethune made blood counts in a series of 27 cases of severe traumatic shock. "All but eleven had a capillary count which amounted to 6,000,000 red corpuscles or higher, and in eight cases it was more than 7,000,000 corpuscles." Venous counts were also made at the same time, and

from these considerations it seems evident that the difference between capillary and venous red counts varies roughly with the degree of shock, and, since the venous count is approximately at the normal level or below it, the difference is due to concentration of the blood or stagnation of corpuscles in the capillaries.

Wright<sup>7</sup> says, "The plasma bicarbonate content is lowered in shock; this has been attributed to anoxemia, which causes incomplete combustion of carbohydrates and possibly of fats in the tissues with the formation of acid products which pass into the blood."

*Reduction of Alkali Reserve in Shock.* Bayliss states that "a part of the normal bicarbonate content becomes neutralized by combination with some fixed acid (lactic, etc.) produced in the tissues on account of the defective oxygen supply." Henderson and Haggard attribute this to over-ventilation of the lungs by rapid breathing. Cannon states that "the reduction of the alkali reserve is an indication of a fundamental difficulty occurring in the body, namely, an insufficient oxygen supply."<sup>12</sup>

Continuing in Cannon's<sup>13</sup> own phraseology:

The failure of delivery of sufficient oxygen to the brain is likely to affect profoundly the normal metabolism of nerve cells in particular, and to lead to a disturbance of their functions. It becomes a matter of importance, therefore, to know at what point in an impaired circulation the oxygen delivery to organs becomes inadequate.

Rost<sup>61</sup> says, "Cobbett and Valte . . . see an increased viscosity of the blood as the cause of shock. . . . Short could not demonstrate this condition." In a discussion of fat embolism in surgical shock, Moynihan<sup>43</sup> says, "That the presence of fat in the blood stream in shock greatly increased its viscosity was demonstrated by Gauss."

*Viscosity of the Blood in Shock.* Cannon<sup>13</sup> says the increase in the number of corpuscles per c.c. increases the viscosity of blood in shock. He says also that "another way in which the viscosity factor might become prominent is through concentration of the corpuscles due to slowness of the blood flow itself." (Work of Cohnstein and Zuntz and by Mall and Welch cited.)

*H-ion Concentration of the Blood in Shock.* According to Kilduffe,<sup>66</sup> "When the blood pressure is lowered by shock, there is a fall of pH, and the same is true of hemorrhage."

Blalock<sup>42</sup> disagrees:

The fall in blood pressure precedes a significant increase in the hydrogen-ion concentration of the blood. It is only in the terminal stages of shock that the alkali reserve is markedly reduced.

Crile,<sup>15</sup> also, says that H-ion concentration of blood is increased "in every type of intense overwhelming activation—by intense exertion, by intense emotion, by intense trauma; it was increased also by inhalation anesthesia, by hemorrhage . . . (etc.)."

Aub and Cunningham<sup>67</sup> conclude that

1. There is a markedly diminished oxygen content of the venous blood in experimental traumatic shock. This change occurs before the blood pressure falls to a shock level and

is still present after apparent recovery from shock. . . .

*Are the Blood and Lymph in Shock Toxic?* Elman and Cole<sup>68</sup> carried out animal experiments to discover if possible whether or not blood and lymph in shock are toxic. "Without describing in detail these experiments it was apparent that none of the injected material proved toxic; and, when it was, there was no essential difference over the controls."

Earlier investigators and advocates of the "traumatic toxemia" theory of shock would disagree with the foregoing statement on the basis of experimental work as well as clinical observation.

Orr<sup>12</sup> summarizes findings which "present rather strong evidence that following trauma there is an absorption of toxic protein material from the damaged tissues which is a factor in the production of the shock state."

*The Factor of Toxins in the Production of Shock.* In their "Note on Muscle Injury in Relation to Shock," Bayliss<sup>69</sup> and Cannon say in part: "And, just as in the animal experiments recorded above, the injured muscle would produce metabolites, which, on being absorbed into the blood stream, would indicate their presence by a decrease in the blood pressure, with other signs of shock."

Robertson<sup>20</sup> notes that "Incoagulability of the blood is one of the symptoms of profound anaphylactic shock. . . ."

*Leucocytes in Shock.* Other statements with regard to blood characteristics in shock follow: Orr<sup>12</sup> says,

Following severe trauma a leucocytosis as high as 20,000, or even higher, may develop within one or two hours. This leucocytosis rapidly diminishes and usually disappears within forty-eight hours. The reason for this rapid rise in the white cell count is certainly not infection. It is apparently due to the absorption of traumatic products. These clinical observations do not correspond to the observations of Crile and Mann, who found a decrease in leucocytes in experimental shock.

*Sugar Content of the Blood in Shock.* With regard to the sugar content of the blood in shock, Cannon<sup>13</sup> says, . . . there is no lack of sugar in the blood; indeed, . . . the amount is actually above the normal (0.1 per cent). Furthermore, there appears to be no relation between the variations of the carbon dioxid capacity of the blood and the percentages of sugar."

Aub and Wu,<sup>70</sup> studying experimental traumatic shock, conclude: "1. Animals with marked muscle trauma but without true shock showed only slight changes in total non-protein nitrogen, urea, creatin and sugar in the blood. These constituents, especially the creatin and the sugar, rose markedly as shock developed. In control animals the determined constituents showed no appreciable change. . . ."

Scarpello's<sup>71</sup> researches induce him to conclude that

. . . in traumatic shock the increase in the blood sugar is due chiefly to an alteration of the glucoregulatory functioning of the hepatic cells. It is not easy to give an explanation of this phenomenon. It is probable that various factors act on the liver and increase the glycolytic functioning. By way of a simple hypothesis, it might be assumed that the traumatic shock causes disturbances in the field of the sympathetic nervous system which in turn act on the hepatic cells and increase the glycogenolytic functioning. On the other hand, it is not impossible that the disturbing movements of the intestine cause an absorption by the portal system of toxic substances, which, as has been shown for various toxins (Delbet, Marmier), may stimulate the hepatic cells to an increased glycogenolysis.

*Nitrogen Content of the Blood in Shock.* Cannon<sup>13</sup> says, "By a chemical analysis of the blood of wounded men, Duval and Grigaut determined that, parallel with a diminution of the non-protein nitrogen of traumatized tissues, there was an increase of non-protein nitrogen and of residual nitrogen (i.e. total non-protein nitrogen minus urea nitrogen) in the blood." In his study of "Certain Aspects of the Metabolic Response to Injury," Cuthbertson<sup>72</sup> con-

cludes: "(7) The curves of urinary excretion of nitrogen and the basal consumption of oxygen are generally parallel."

*The Basal Metabolic Rate in Shock.* With regard to the basal metabolic rate in shock, Aub<sup>73</sup> says in conclusion,

. . . (2) Experimental traumatic shock causes a marked fall in the rate of basal metabolism to 70 per cent of the original level. The degree of fall is dependent upon the severity of the shock produced. . . . (4) The effect of hemorrhage is not constant. It may temporarily lower, or have no immediate effect on the metabolic rate. (5) Recovery from shock after blood transfusion is usually associated with a prompt return of the metabolic rate to a normal level.

*Systemic Effects of Shock.* Regarding the systemic effects of shock, Atchley and Loeb<sup>11</sup> say,

The most significant effect is the interference with tissue function which results from circulatory stasis and diminished blood supply. No organ shows this disturbance more strikingly than does the kidney. Renal function is compromised and anuria frequently results. This, in turn, definitely upsets the acid base equilibrium of the body and in the case of diabetic shock prevents the excretion of ketone bodies, thus adding to the seriousness of the disease state. The tissues of the central nervous system are also included in the general damage and the resulting pathology doubtless plays a large part in the terminal stages.

*Shock and Hemorrhage.* Reference may be made briefly to the distinction between shock and hemorrhage. Crile<sup>17</sup> writes as follows: "In the absence of a history of either trauma or bleeding, without evidence of free fluid in cavities, and without a blood examination, . . . we believe it (differentiation between shock and hemorrhage) cannot with certainty be done." Orr,<sup>12</sup> discussing changes in the blood picture in shock, quoting from Crile's work, states that

there is either a slight or no fall or a rise in hemoglobin, and in hemorrhage there is at first little or no fall, but after the loss of a fourth, a sixth, or a tenth of the fatal amount

of blood the hemoglobin begins steadily to fall. The red cell count follows rather closely the curve of the hemoglobin in both hemorrhage and shock. Crile found relatively slight change, sometimes a fall in the leucocytes in shock, and in hemorrhage in every instance a rising leucocyte count. He then concludes that repeated and accurate observations upon the blood picture may differentiate between hemorrhage and shock.

Blalock<sup>74</sup> quotes from an editorial in the Journal of the American Medical Association<sup>111</sup> which summarizes work by Moon and Kennedy:

In shock the blood becomes more concentrated, as shown by specific gravity, hemoglobin, and erythrocyte count; following hemorrhage, dilution of blood occurs. In shock there is widespread capillary dilatation of the viscera, congestion accompanied by edema and petechial hemorrhages; following hemorrhage the tissues are anemic. The differentiation of hemorrhage and shock is of more than academic importance. It is well known that recovery follows the introduction of physiologic solution of sodium chloride into the circulation of patients suffering from the simple loss of blood. The futility of this procedure in shock has been proved beyond question. The increased permeability of the capillaries, which is a characteristic feature of shock, allows saline solution to escape rapidly into the tissues. Solutions containing acacia or dextrose have been found more effective than saline solutions but not so effective as transfusion of blood. Even the latter is ineffective in profound shock.<sup>74</sup>

*Is Differentiation between Shock and Hemorrhage Possible?* Archibald and McLean, quoted by Orr,<sup>12</sup> also observed "that in hemorrhage intravenous saline solution was helpful, but useless in severe shock." Macleod<sup>75</sup> says, "The diagnosis (i.e. between surgical shock and hemorrhage) is clinched by the effect of transfusion; the hemorrhage case quickly recovers whereas that in shock only slowly, if at all." According to Bickham,<sup>6</sup> "marked hemorrhage results in collapse, rather than in shock—although differentiation of the phenomena is not easily made." Cannon<sup>13</sup> is even less

discriminatory: "Shock is hemorrhage and hemorrhage is shock."

Mann and Essex<sup>33</sup> point out that

shock and hemorrhage are identical in one respect, namely, that there is a decrease in the amount of circulating blood in both conditions. Thus there is a similarity in the physiologic aspects of the two conditions, although the pathologic findings may be quite different. This conception of the relationship between shock and hemorrhage explains the fact, which has been demonstrated so frequently both clinically and experimentally, that a hemorrhage which would be insignificant in the normal state will aggravate or prove fatal in the condition of shock.

Cutler and Scott<sup>60</sup> say:

The immediate effects of severe hemorrhage and shock produce the same syndrome by the same mechanism, viz., a diminution in the circulating blood volume. There is the difference that in shock uncomplicated by hemorrhage the blood is concentrated without loss from the body of the erythrocytes which to a large extent remain in the capillary bed, whereas in case of active hemorrhage the red cells and their contained hemoglobin are lost to the body. This fact is demonstrated by a study of the difference in the recovery of the two types. Thus, after making up the blood volume lost by a large hemorrhage the hemoglobin figure is much lower than after a corresponding degree of shock not caused chiefly by hemorrhage for in the latter instance viable cells are brought back into the circulation.

Rhodes and McKenney<sup>76</sup> make the following distinctions:

If hemorrhage is the major factor, the clinical picture is altered in that: (1) The apathy is replaced by anxious alarm. (2) Instead of the passive immobility of shock there is restlessness and often a marked degree of muscular activity. (3) The shallow rapid respiration is replaced by deeper and more labored breathing, which is terminally aptly described as typical air hunger. (4) The examination of the peripheral blood shows a diminution in red blood cells and hemoglobin as in secondary anemia, thus differing markedly from the findings in shock. There is also a leukocytosis with a relatively high percentage of polymorphonuclear ele-

ments, and when the hemorrhage is internal there is a rapid and very marked increase in white blood cells.

Palfrey<sup>28</sup> believes that

the constitutional effects of hemorrhage have one important difference in their course from those of shock. . . . In shock, the symptoms and the fall in the blood-pressure readings occur progressively. In gradual hemorrhage, on the contrary, although the pulse rises progressively, the symptoms tend for a time to be in abeyance, and the blood-pressure tends to maintain itself until at last, quite suddenly, there is a great fall in blood-pressure with serious symptoms of collapse.

*Recent Work on Surgical Shock.* Concerning recent work on surgical shock, there is in a late issue of the Journal of the American Medical Association<sup>113</sup> the following announcement:

Dr. John Beattie, conservator of the museum of the Royal College of Surgeons, (London), described recent work at the college laboratories on surgical shock. Experimental animals showed three stages. The first fall in blood pressure after trauma was due to loss of fluid. The period of recovery might last thirty minutes and then a gradual fall, terminating in death, took place. The work done in the laboratories pointed to the conclusion that the loss of fluid during the first phase was not the cause of death, which was due to something happening in the second stage, probably associated with impulses passing along the sympathetic nerve. Perhaps these impulses brought about some change in the central nervous system that was irreversible, and in consequence the blood pressure kept on falling until it became so low that death was inevitable. An animal shocked by trauma of the hind limb might die in two and one-half hours. But if the spinal cord was blocked by procaine hydrochloride the blood pressure was maintained and the animal was prevented from passing into a condition of shock. Cross circulation experiments confirmed the conclusion that the lethal factor in shock was abnormal nerve impulses.

*Introduction to Consideration of Treatment of Shock.* As an introduction to a discussion of the treatment of shock, a statement by McDowall<sup>77</sup> is a propos: "I

propose to . . . emphasize that shock is not a single entity, but may be produced experimentally and clinically from a variety of causes, and that any single remedy used without understanding of the case in hand is bound to give most contrary results."

*Measures Directed toward Prevention of Shock.* Orr<sup>12</sup> says,

In the civil practice of surgery, serious consideration should be given to the prevention of surgical shock. Much can be done to avoid this complication by properly studying and preparing the patient for operation. It appears obvious that a patient with diseased kidneys, impaired function of the liver, failing circulatory system, cachexia, anemia, toxemia or other conditions which lower the general bodily resistance, might more quickly develop shock than the patient whose vital functions are practically normal. In addition to the careful study of the patient's physical condition, care should be taken not to lower his resistance by ill-advised preoperative surgical preparation. Depleting purges, starvation, dehydration and excessive anxiety should be avoided as much as possible.

In many cases, transfusion, hypodermoclysis of physiologic sodium chloride or infusion of glucose solution before or during an operation will prevent shock. The proper selection of an anesthetic is of utmost importance. Every surgeon should have a good working knowledge of the various types of anesthesia and should make this choice to suit the patient. . . Careful protection of the patient from cold before, during and after operation is essential. Trauma should be minimized always. The judicious use of sedatives to relieve pain and restlessness is not only fair to the patient, but may lessen the shock of anesthesia and operation.

*Spinal Anesthesia Advocated in Shock.* O'Shaughnessy and Slome<sup>55</sup> advocate spinal anesthesia for shock sufferers. They say in part,

The one therapeutic measure which (we have found) succeeded in raising and maintaining the blood pressure of a traumatized cat whose pressure had sunk to 20 mm. of mercury was the induction of spinal anesthesia. In some cases this measure has been combined with injection of saline into the peritoneum,

with apparently beneficial results. It is of course possible that some better method of controlling nociceptive impulses may be devised—the injection of a local anesthetic into the traumatized area suggests itself as one possibility—but we are convinced that control in some form is essential to the successful treatment of the syndrome. Even if we are wrong in the emphasis we lay upon the discharge of nociceptive impulses, the beneficial effect of spinal anesthesia remains a fact which seems worthy of note and further investigation.

*Anesthesia and Shock Prevention.* Another note regarding anesthesia in shock previously quoted from an article by Jones<sup>39</sup> is repeated here: "local nerve block with a cocaine derivative (nupercain) lessens damage to the central nervous system, allows relaxation with minimal anesthesia, and prolonged freedom from pain in the postoperative period."

Crile's<sup>15</sup> testimony is that "We have found that the acute exhaustion (shock) of surgical operations may be minimized or prevented by blocking the field of operation with local anesthetics, or by preventing the response of the brain-cells to the stimulus of traumatic impulses by nitrous oxide anesthesia."

Cutler and Scott<sup>60</sup> declare that

If the blood volume can be maintained in the early stages before the capillary permeability has been irreparably depressed, the serious phases of shock and hemorrhage never appear and the circulatory efficiency is kept above the critical level. This makes it clear how important it is to be able to estimate the available volume of circulating blood.

These authors say also concerning prevention of shock:

Postoperative hemorrhage and shock are prevented (1) by operating upon patients only when they are in a condition at least as regards their circulatory mechanism, which we designate as "good risk," i.e. their heart action, their vasomotor tone and their blood volume are as near normal as possible; and (2) by utilizing careful surgical technique. This means perfect hemostasis during the operation, care-

ful tying of ligatures, gentleness in handling tissues, and asepsis.

*The Dangers of Persisting Low Blood Pressure.* Under caption of "Principles underlying proper treatment," Rhodes and McKenney<sup>76</sup> say,

. . . If the low blood pressure with its reduced volume flow is sufficiently persistent, permanent cellular changes are brought about in the higher nerve centers, and these ultimately result in paralysis of the vasomotor center. Herein lies the great need for early treatment in shock for once the vasomotor center has become permanently damaged by the anoxemia, vascular tone is lost. When this loss of vascular tone exists, our efforts to combat shock, particularly those endeavoring to restore fluids, will be fruitless. The problem accordingly resolves itself into an attempt to interrupt the chain of events which leads to these typical vicious circle reactions.

Wallace,<sup>78</sup> who had an extensive experience with shocked patients at the battle front, states that "all the established methods of treatment were used, but warmth combined with rest greatly outstripped all others in favour."

*Treatment of Shock More or Less Independent of the Cause.* Atchley<sup>45</sup> says,

The treatment of shock is more or less independent of its cause. Whether it is due to trauma, toxemia, hemorrhage or anhydremia, the physiologic problem is the same; namely, a disproportion between the blood volume and vascular bed. On one hand there is primarily decreased blood volume from hemorrhage or fluid loss; on the other increased vascular bed from capillary dilatation. The need for immediate measures to increase blood volume is common to all types.

A point of view opposite from that quoted is found in an article by Andrews.<sup>79</sup> He says, "The treatment for the various sorts (of surgical shock) is quite specific and if applied to the wrong kind, may be definitely detrimental."

*Shock a Safety Reaction of Nature.* In considering the treatment of burns Clark and Cruickshank<sup>80</sup> make an interesting observation: "Shock in itself may be

Nature's effort to deaden pain and tide the patient over the initial phase of his injury, and its treatment should be conservative. Loss of fluid should be prevented as far as possible and replaced by the most suitable methods."

*Principles Underlying Selection of Proper Drugs for Treatment of Shock.* Says Johnson,<sup>81</sup> of Chicago,

The method of treatment of acute surgical shock or of shock due to hemorrhage when the predominating symptoms are low blood pressure, weak and thready pulse, and depression of the central nervous system has always been unsatisfactory as far as the use of drugs is concerned.

As a rule, in this type of shock a vicious circle is established in which depression of the blood pressure causes further depression of the central nervous system and vice versa. In some instances it appears as if the central nervous system depression is the predominant factor which leads to loss of vasomotor tone with a lowering of blood pressure. In other cases the low blood pressure seems to be the essential factor with consequent central nervous system depression.

In the choice of a drug designed to overcome this vicious circle, several factors ought to be considered, the most important of which are as follows:

1. The drug should be non-toxic with a high margin of safety; i.e., a drug that will not cause a toxic reaction in already depressed circulatory and nervous systems.
2. It should have a pronounced hemodynamic action as well as a marked stimulant action on the central nervous system.
3. These actions of the drug should be of a lasting character in order that the various body systems may regain the physiologic state lost by the previous inadequate circulation of blood through them. If the drug has a lasting action, time will be available for the institution of other supportive measures.

This author<sup>81</sup> states that "ephedrine seems to exhibit these characteristics."

*Use of Coramine in Shock.* Wood,<sup>82</sup> reporting on the efficacy of coramine, says,

1. Coramine is a definite stimulant to respiration and circulation depressed by avertin, novol, or in surgical shock.

2. The toxicity of coramine is low; so that large and repeated doses may be employed if the necessity exists. This is well illustrated in one of our cases, where 28 c.c. were given in a period of sixteen hours with apparently excellent results. Further, that in this series there was no evidence of depression after the immediate stimulation . . .

*Use of Morphine in Treatment of Shock.* Orr<sup>12</sup> says, "Undoubtedly morphine should be given in many cases of shock. . . . Crile and Lower have recommended giving morphine until the respiration is reduced to 12 per minute." According to Solis-Cohen,<sup>53</sup> "In conditions of surgical shock, morphine is sometimes the best agent that can be employed. In other cases, strychnine or epinephrine may be preferable."

In Marshall's opinion, "the severely wounded do not make good recoveries from operation if deeply morphinized."<sup>12</sup> Orr<sup>12</sup> quotes Cannon's report of experimental observations

made by Cattell at Dijon upon the relationship between the use of morphine and the change in alkali reserve. The results show that morphine prevents the fall in alkali of the blood and that, in cases of low blood pressure with an already low carbon dioxide combining power, there is a rise in alkali approaching normal. The explanation for this effect of morphine is not clear, but it is probably due to a reduction of bodily activity, with a resulting decrease in tissue demand for oxygen.

Henderson<sup>54</sup> points out also that "one of the principal effects of morphine is to decrease and in sufficiently large dosage, finally almost to abolish the sensitivity of the neurorespiratory system to its normal stimulus, carbon dioxide."

Regarding the use of adrenalin in shock, MacFee and Baldrige<sup>55</sup> say,

Adrenalin to raise blood pressure is to be condemned. Acting as it does upon the arterioles, its effect is to raise the blood pressure in the arterial tree. But, as pointed out by Cannon, this does not improve the volume flow in the capillaries. " . . . Merely a higher arterial pressure is not the desideratum in the treatment of shock, but a higher pressure

which provides an increased nutritive flow through the capillaries all over the body."

These authors<sup>55</sup> declare that "cardiac stimulants, in the absence of organic cardiac disease, are generally uncalled for."

*Adrenalin Insufficiency (?) in Shock.* Swingle, Pfiffner, et al.<sup>55</sup> express the suggestion that "the signs and symptoms of adrenalin insufficiency, and of traumatic or secondary shock are possibly due to one and the same thing, i.e. failure of the blood volume and blood-diluting regulator mechanism, the adrenal cortex."

*The Relationship of Adrenal Cortex Hormone to Shock.* There has been considerable criticism and discussion of Swingle's work and publications. Freeman<sup>56</sup> believes

The investigators (under discussion) have clearly demonstrated that the cortico-adrenal hormone is a specific therapeutic agent for the shock which is associated with absence of the adrenals, but they have not reported experiments in which the effect of cortin has been assayed in traumatic shock. . . . Although the analogy between deficiency of cortico-adrenal hormone and traumatic shock is a close one, no convincing evidence has been presented that the two conditions have a common etiology or that the cortical hormone is of benefit in the treatment of shock.

Britton and Silvette<sup>57</sup> say,

Our own observations lead us to conclude that changes in blood pressure and in the amount of circulating blood are indirect and illustrative only of the general effects of adrenalectomy throughout the body. . . . Our data compel adherence to our first proposed theory of the adrenal cortex—that of the regulation, in cooperation with other tissues or secretions, of carbohydrate metabolism in the organism.

*Functioning of Adrenal Cortex as Related to Shock.* Parkins and his co-workers have done considerable experimental work on the subject of results of adrenalectomy in relation to the shocked state of animals. Their experimentation leads Swingle and Parkins<sup>58</sup> to report in part that "The data

indicate that the unoperated dog has sufficient reserve hormone in his intact functioning adrenal cortical tissue to prevent shock following hemorrhage and trauma. . . . The adrenalectomized animal enjoying good health but lacking such reserve hormone, succumbs to shock as a result of trivial injury."

*Shock Causes Marked Reduction in Functional Efficiency of Adrenal Cortex.* Experimental data is presented by Donahue and Parkins<sup>89</sup> indicating

that following trauma and the onset of secondary shock the adrenal cortex is subjected to severe functional strains leading to a marked depletion of lipoid, gross hemorrhages into the gland and vacuolization of cells. These changes are indicative of marked reduction in the functional efficiency of the cortex in this syndrome (i.e. shock).

Parkins et al.<sup>90</sup> have also reported evidence that "The adrenalectomized dog although in equally good physiological condition is far more susceptible to the decrease in serum sodium and chloride and associated disturbance in fluid balance following intraperitoneal injections of isotonic glucose than is the animal with intact adrenals."

*Use of Stimulant Drugs in Shock during the Great War.* Cannon<sup>13</sup> says with regard to the use of drugs in treatment of shock: "In British and American services the use of stimulant drugs, such as strychnin, and also vasoconstrictor drugs, such as pituitrin and adrenalin, practically disappeared during the course of the recent War." The results of such experience as that on which Cannon bases his statements must always take precedence over conclusions such as those expressed by Harrower,<sup>91</sup> e.g., who says: "For years it has been known that adrenalin offers a life-saving service in shock and heart failure. The best method of administering adrenalin in cases of ordinary shock is by intravenous infusion of high dilutions in saline solution."

*Epinephrine and Pituitary Solutions in Treatment of Shock.* Summarizing their recent experimental work with pituitary

and with epinephrin solutions, Blalock et al.<sup>92</sup> say:

Experiments were performed in which a decline in blood pressure was produced by the introduction of histamine, of unpurified acacia and of incompatible blood, and salt solution was injected continuously intravenously. The introduction of solution of pituitary or of epinephrine in the amounts used in these experiments did not prevent the loss of protein from the circulation.

Friedlander,<sup>34</sup> also, concludes that

Epinephrin and pituitary extract are of no value in the treatment of secondary shock. . . . And Cannon adds that the desideratum in shock is a higher pressure which provides an increased nutritive flow through the capillaries all over the body. This cannot be brought about by any medication, but only by such measures as will definitely increase the blood volume and thus help the volume flow through the capillaries.

Atchley and Loeb<sup>11</sup> believe that

The use of vasoconstrictors, such as epinephrine, is not helpful and may, indeed, be dangerous. From a physiological standpoint they are contraindicated because the blood vessels which they affect are already constricted to the disadvantage of the capillary circulation, as has been shown by studies of both the skin and visceral arterioles.

*Parathormone in Treatment of Shock.* McDonagh<sup>40</sup> proposes that parathormone be used, declaring that "Parathormone is a conductor, it causes dispersion of hydrated particles, and is of equal value in preventing histamine from producing shock, insulin from producing convulsions as it is in preventing guanidine, etc., from producing tetany."

Palfrey<sup>28</sup> says that of the stimulant drugs, "caffein sodio-benzoate, grs. 2-3, given intravenously, is the one most generally believed in." He thinks "epinephrin (1:100), minims xv, added to normal salt solution and given intravenously is of value."

*Caffein and Digitalis in Treatment of Shock.* Rhodes and McKenney<sup>76</sup> declare



that "Caffein in large doses is used almost routinely as the proper stimulant for the patient in the shock state. Certain observers recommend also various cardiac stimulants of the digitalis group for these patients. The value of both caffein and digitalis is probably over-estimated, as apparently there is no intrinsic myocardial fault demonstrable."

Wangensteen<sup>21</sup> says "Blalock found that digitalis in shock lowered the minute cardiac output, and he concluded that its use in shock is actually harmful. It is to be remembered that the contractile power of the heart is normal in shock and that it is not in need of stimulation."

*The Use of Drugs in Treatment of Surgical Shock.* Wangensteen says elsewhere,<sup>93</sup> with regard to use of drugs in treatment of surgical shock,

In the fall of blood pressure accompanying spinal anesthesia and that occurring after sudden removal of large quantities of fluid from the body cavities, the administration of vasospastic agents is urgently indicated, for in these conditions there is an actual lowering of the tone of the vessels. In these conditions too, the Trendelenburg posture has its greatest value.

Later in this same article the author says, "Even though patients in shock suffer more from depletion of blood volume than from want of oxygen carriers, the most effectual means of restoring a diminished blood volume is transfusion of blood."

The conclusions of Cutler and Scott<sup>60</sup> regarding treatment of shock may represent the general consensus of opinion: "Other than transfusion and the administration of fluid, heat and morphia will do more to restore vasomotor tone than all the other procedures advocated."

"Of all methods of intravenous treatment in shock," says Orr,<sup>12</sup> "blood transfusion most nearly approaches the ideal. It will raise the blood pressure, increase the blood volume and, in addition, supply oxygen-carrying corpuscles."

Fluids should be introduced into the body by whatever means is best suited to

the particular case. Brandson and Hillsman<sup>94</sup> say,

The use of fluids is invariably directed towards maintaining the acid-base balance, electronic concentration and blood volume.

To resist the various disturbances to which the organism is constantly subjected these processes have formed a defensive alliance. A disturbance in any one is resisted as far as possible by the specific process involved. When this process is unable to further cope with the situation the other two are called upon for aid, until by mutual assistance the biochemical balance is again established.

*Saline Solution in Treatment of Shock.* These authors<sup>94</sup> say further:

In saline we have a solution that will restore very promptly in all surgical conditions the acid-base balance, electronic concentration and the blood volume. The chief base of the blood is sodium; the chief acid is chlorine; the great bulk of the blood volume is water; and the electronic concentration is chiefly maintained by retention, excretion and diffusion of sodium, chlorine, and water. Give to the organism a sufficient quantity of isotonic saline solution and it will by selective action retain sodium and discard chlorine in the presence of an acidosis, retain chlorine and discard sodium in the presence of an alkalosis, and utilize the sodium, chlorine and water to distribute between blood stream, tissue space and body cell, to establish electronic balance and restore blood volume. In order to correct all three processes simultaneously the saline must be isotonic, as saline in any other concentration will affect the electronic concentration and force readjustment of the other two processes.

*Hypertonic Solutions.* Padgett and Orr<sup>95</sup> say that "hypertonic solution of crystalloids have not been used with complete success in the past in the treatment of well developed shock. Recently, evidence is accumulating that intravenous therapy with hypertonic solutions of crystalloids, unless introduced with the greatest care, may be actually harmful."

Cutler and Scott<sup>60</sup> state that

It has been shown that the administration of large amounts of fluids (by rectum, by

mouth, and subcutaneously or intravenously) washes out into the general circulation cells which presumably are stored against such an emergency. . . . The spleen may be such a reservoir. The investigations of Robertson and Bock seem to indicate that even immature forms of red cells, possibly from the bone-marrow, are freed into the circulation following the administration of large amounts of fluid. Such cells, of course, have a greater permanency of value than transfused cells, and in all such cases a high fluid intake is essential.

*Temporary Effect of NaCl or Ringer's Solution.* "Bayliss (Intravenous Injection in Wound Shock, London, 1918) has proved quite conclusively," says Orr,<sup>12</sup>

that the injection of physiologic sodium chloride or Ringer's solution has only a temporary effect in the treatment of severe shock. A rise in the blood pressure follows the injection, but within an hour it usually returns to its previous level. The solution literally leaks out of the blood stream into the tissues. Hypertonic sodium chloride solution raises the blood pressure, but its effect is usually transitory. The high osmotic pressure of the hypertonic solution probably draws additional fluid into the blood stream, but this again passes out through the capillaries as soon as dilution takes place.

Orr<sup>12</sup> quotes Cannon, Fraser, and Cowell as recommending use of 4 per cent sodium bicarbonate solution in treatment of shock, stating that "before or during operation it raises the blood pressure during the critical period. This solution also increases the alkali reserve."

Shelton<sup>86</sup> recommends the use of "a pure 5 per cent dextrose solution in Ringer's solution (which) may be given intravenously continuously for days . . . Usually an intravenous cannula is employed, but for a period of a few hours the intravenous hypodermic needle is often satisfactory. In cases of shock this method is of great value."

*Glucose-insulin Treatment in Shock.* Wade,<sup>97</sup> in 1929, wrote in summary,

. . . (2) Glucose intravenously with insulin subcutaneously in the treatment of shock

gives results which, in this series, seems more satisfactory than those obtained in cases treated by saline or glucose alone. (3) Cases of traumatic shock respond most readily to this treatment. (4) Cases of postoperative shock treated in this manner show marked improvement. (5) The optional dosage is 1000 c.c. of a 5 per cent or 10 per cent solution of glucose with one unit (U20) of insulin to three grams of glucose. Beneficial results are usually apparent after 800 c.c. of fluid have been injected.

The conclusion in regard to the glucose-insulin treatment reached by Padgett and Orr,<sup>95</sup> however, is that "from the experimental standpoint the glucose-insulin treatment of shock recently advocated by Fisher seems to be no more beneficial than treatment with a hypertonic solution of glucose or sodium chloride."

More recent is the opinion expressed in an editorial note<sup>112</sup> published by the Journal of the American Medical Association in response to a query submitted by a Kentucky physician with regard to the use of dextrose intravenously in the treatment of shock:

. . . Aside from supplying water and sodium chloride—the latter is important and should be provided in the solution—during a state when there is a drain on the system without chance for replenishment through the ordinary channels, the dextrose may antagonize starvation acidosis, and that is all the good dextrose-saline solution can do in shock. As this is therefore merely a matter of replacement of nutritional essentials, it has no place in the early treatment of shock. . . . When blood has been lost, it may be of detriment rather than of advantage, as it is likely to lower still further the percentage of corpuscles in the circulating blood. . . . When there has been a great loss of salt from the system, as by excessive emesis, hypertonic (10 per cent) sodium chloride solution may be the most important emergency remedy. Hypertonic dextrose solution should be avoided, as it causes crenation and possible destruction of blood corpuscles when none can be spared; and it will still further increase the existing state of hypohydration of the tissues. . . . One should therefore employ drip phleboclysis,

using equal parts of 5 per cent dextrose and 0.9 per cent sodium chloride solution, as the first offering of diet to a patient who is emerging from shock and who is presumably or actually in such a condition that he is not likely to benefit from the ingestion of fluid by mouth. Excepting in a case of diabetes mellitus, insulin should be employed only when sugar appears in the urine of a patient who is given dextrose phlebotomy and then only in guarded dosage to make hypoglycemia impossible.

As has been noted in the foregoing, Cannon<sup>13</sup> found that the blood sugar in shock is above normal, and that it is not related to the decreased alkali reserve. Acetone bodies were absent from the urine . . . "It seems probable that the beneficial effects of glucose are due largely to the water introduced with it." This statement is made by MacFee and Baldrige.<sup>65</sup>

*Glucose and Histamine Shock.* Mention should be made of an abstract of an article by Djuricic<sup>98</sup> on the subject of "glucose and histamine shock" which says, "Contrary to what happens in anaphylactic shock, glucose exerts no protective action in histamine shock. This is another fact which is not in accord with the view that the two forms of shock have the same mechanism."

*Gum Solution in the Treatment of Shock.* "In 1919" says Friedlander,<sup>34</sup>

Erlanger and Gasser\* published the results of their experimental studies of shock treated with hypertonic gum solutions. They used solutions containing 25 per cent of gum acacia and 18 per cent of glucose. They found that such a solution acts beneficially in the treatment of shock, (a) by drawing fluid from the tissues to the blood stream, thus aiding in restoring blood volume, (b) by maintaining this increased volume through some property of the acacia, (c) by dilating arterioles through some specific action of the hypertonic crystalloid, (d) by increasing the energy of the heart-beat in the same way, also through the direct action of glucose on the heart muscle, (e) by augmenting metabolism through increase in the supply of glucose to the organism.

\* *Ann. Surg.*, 69: 389, 1919.

Randall,<sup>99</sup> reporting on the use of intravenous solution of acacia in the Mayo Clinic in the treatment of shock, makes the following statements:

The total number of patients in all services at Mayo Clinic who received intravenous injections of solution of acacia in 1928 was 118 . . . Acacia apparently fulfils all the requirements for intravenous treatment of shock except furnishing erythrocytes. It has been proved to be innocuous in several series of cases. It increases the volume of plasma and blood and keeps it increased until the normal fluid-regulating mechanism of the body is restored. As preventive of shock I feel that it is often well to give an injection of solution of acacia in cases in which the patient is fatigued or debilitated and in which obstetric operations are to be performed.

Huffman<sup>100</sup> summarizes his findings with acacia and sodium chloride solution as follows:

Gross evidence of toxicity was not seen following the intravenous injection of solution of acacia and sodium chloride in shock. The blood pressure increased, the pulse rate decreased, the respiration deepened and the general condition of the patient improved. The need for transfusion was often obviated. In some cases, increased output of urine was noted. Injurious effects on the kidneys were not seen. Chemical changes in the blood of a harmful nature were not apparent. Physico-chemical changes in the blood did not lead to harmful alterations in physiologic processes. Six days is usually required to rid the blood of acacia. Pathologic change resulting from the acacia was not demonstrated at necropsy. The therapeutic usefulness of solution of acacia and sodium chloride is confirmed.

Macleod<sup>75</sup> notes "two precautions necessary to success in using the gum solution, first they must be properly prepared, and second they must not be injected so rapidly that their high viscosity would slow the circulation and so embarrass the heart's action." Erlanger, Gasser, et al.<sup>101,102</sup> early presented several articles reporting favorable experimental results with gum acacia in treatment of shock. Good and Boyer<sup>103</sup>

are among more recent advocates of the use of this solution.

*Unfavorable Comment Regarding Intravenous Use of Acacia.* Lund, of Boston, in discussing an article by Frazier<sup>104</sup> says,

I think . . . that the acacia problem is not finished. Acacia stays in the blood a long time. It has been recovered six months or longer after introduction. It is a gummy solution and, according to a pharmacologist, tends to coat and clog the capillaries in the liver. In reasonable amounts, I am sure that it can do nothing but good, but I think that repetitions of doses of acacia, say, 500 c.c. three or four times in twenty-four hours, and three or four times more in the next twenty-four hours, might be bad, and I would like to see animal work done to find what the upper limit of tolerance of acacia in the way of dosage is.

In the consideration of ways and means of administering fluids by the intravenous routes, Wenger<sup>105</sup> says,

I have found it difficult to give large quantities of fluid intravenously with the usual gravity method. Among other objections, this gravity method is too slow. Because of these inconveniences, the Scannell apparatus for transfusion was used. However, it is cumbersome and somewhat complicated. The apparatus described below is an outgrowth of these difficulties.

*Apparatus for Intravenous Treatment of Shock.* A glass T-tube is inserted between the gravity tube and the needle, which needle should preferably be of the type with a shield to rest on the patient's arm. To the perpendicular of the T-tube, by means of rubber tubing, a 50 c.c. Luer syringe is attached. The other equipment required is the ordinary infusion bottle for transfusion and an artery clamp.

The artery clamp is placed on the tubing just above the T-tube. When the clamp is removed the fluid flows into the vein and into the syringe displacing the plunger. When the syringe is full, the clamp is reapplied; gentle pressure is exerted on the syringe, thus forcing the fluid into the vein. The clamp is removed and the procedure repeated until sufficient fluid has been given. In my cases 500 c.c. are given in a period of from thirty to forty

minutes. In no case has there been any ill effect from giving the fluid at this rate.

Wenger<sup>105</sup> declares that

the advantages of the apparatus lie in its simplicity; in the fact that the treatment can be given at the bedside; that the patient is but slightly disturbed; that a large volume of fluid may be given in a minimum of time; and that the flow into the vein is continuous. Thus there is no clotting in the needle.

*Four Dangers Associated with Administration of Solutions Intravenously.* In his discussion of an article dealing with the role of intravenous drip in therapy by Hyman and Touroff,<sup>106</sup> Orr points out four major dangers attendant on administering solutions intravenously: (1) the immediate reaction; (2) the possibility of overloading the circulatory tree; (3) the production of edema; (4) the production of pulmonary embolism.

*Treatment of Electrical Shock.* Brief notice may appropriately be made of the treatment of electrical shock. Pearl's<sup>29</sup> summary and conclusions on this subject include the following:

. . . (6) The treatment of electrically induced ventricular fibrillation is prompt cardiac massage, preceded if possible by the intraventricular injection of potassium salts followed by calcium salts. The carotid route for administration of these salts may prove sufficient without the use of cardiac massage. If available an appropriate current may be passed through the heart, followed by cardiac massage.

*Electrosurgery Technique.* It is interesting to note that Schorcher<sup>4</sup> found that "trauma of an electrosurgical procedure produced less shock than that produced by ordinary mechanical means . . . Electrocoagulation destroys the toxicity of the rapidly working toxins because it generates a temperature of 60 to 80 degrees, whereas their activity is inhibited at 59 degrees of heat." The author "believes that he demonstrated in experiments that electrosurgical trauma produces little reaction on the part of the nervous and circulatory systems."

*Artificial Respiration in Electrical Shock.* "Jaffe . . . joins with other recent stu-

dents," says an editorial in the Current Comment section<sup>107</sup> of the Journal of the American Medical Association under date of June 16, 1928, "in stressing the importance of vigorous attempts at artificial respiration. This may effect resuscitation of a paralyzed respiratory center. The passive movements of the chest should be started as soon as possible and continued for a sufficient time, even for hours."

In discussing application of heat as an important procedure in the therapy of surgical and traumatic shock, it may not be amiss to call attention to the use of diathermy for this purpose. The first paragraph of a paper read at the sixth annual meeting of the American College of Physical Therapy by Portmann,<sup>108</sup> of the Cleveland Clinic follows:

*Diathermy in Treatment of Shock.* The use of diathermia in the treatment and prevention of surgical shock is based upon certain experiments which were made a number of years ago. Dr. Crile found that cooling of the liver is one of the most important factors in the production of shock in abdominal operations. In a series of animal experiments Nagelschmidt found that the amplitude and volume of respiration and the heart beat are increased when diathermia is applied through the mediastinum.

*Description of a Device for Application of Heat in Treatment of Shock.* Hitchcock and Reynolds<sup>109</sup> describe an apparatus originally fashioned to expedite cast drying where more or less extensive body casts are required, and later utilized to prevent and to treat cases of shock.

The apparatus consists, essentially, of a cabinet with electrical coils for heating, together with a blower which delivers this warmed air into flexible tubes. These tubes fit, by means of simple coupling devices, into a coiled spring mat which can be laid on a bed or folded around a patient, as any ordinary blanket or mat would be. The coiled springs are covered by fabric, which makes the whole unit into a flexible chamber or a flexible hollow wrapping, through which the heated air circulates, to leave by a vent at its distal end. The principal mat, which envelopes the body and

legs, is augmented by an auxiliary mat, which can be fitted over an arm to which a separate pipe can deliver heated air. The amount of heat delivered is subject to simple regulation by means of switches, so that a greater or lesser degree of heat can be obtained, depending on the needs. . . . This apparatus provides "quick, generalized heat" which "is an important factor in recovery from shock."

*Carbon Dioxide and Oxygen in Treatment of Shock.* Henderson<sup>84</sup> has pointed out recently that "hemorrhage produces its ill effects largely through asphyxia. This is tacitly recognized by surgeons in their preference for transfusion of blood over any mere infusion of a saline or gum solution. The victim of acute exsanguination exhibits air hunger." He recommends treatment with resuscitation methods—the administration of carbon dioxide and oxygen. He says in part:

In shock without hemorrhage there is, however, no loss of red corpuscles from the body, and the blood alkali is merely displaced. Both corpuscles and alkali may be recalled into use. To effect such recall, both the asphyxia and the acarbemia may be combated with inhalation of carbon dioxide and oxygen.

One of the oldest and also the latest of many conceptions of the underlying cause of the depression of the circulation in shock and in illness is that the tonus of all the muscles of the body, both skeletal and visceral, is depressed, and that the blood stagnates in the atonic tissues. Stimulation of respiration with carbon dioxide increases the effective differences of pressure between the tissues of the body and the thorax and thus promotes the venous return to the heart.<sup>84</sup>

*Support for the Theory of the Value of Carbon Dioxide in Treatment of Shock.* Support for Henderson's claims are found in reports of work by other investigators. McDowall<sup>37</sup> says,

The tone of the blood-vessels is kept up by the vasomotor center, the activity of which Dale and Evans have shown to be dependent on the carbon-dioxide content of the blood. It will be clear, then, that any condition which separates the centre from the vessels or which causes the carbon dioxide to be reduced must

result in a fall in blood pressure from not only an increased capacity of the circulation but also a loss of the peripheral resistance of the arteries.

*War Experience with Carbon Dioxide in Treatment of Shock.* War experience, also, serves to establish validity for Henderson's theory of treatment for shock. Porter<sup>44</sup> says in the summary of his lectures on shock: "#13. Increased action of the thoracic pump, brought about by the inhalation of carbon dioxide liberally mixed with pure air, will raise the blood pressure from 15–20 millimetres in normal and wounded men. When the blood pressure is near the critical level this procedure is of advantage." Previously this author<sup>44</sup> had made a point of the fact that "A few mms. above the critical level, recovery will usually occur spontaneously; a few mms. below, death will follow unless skilled aid be at hand."

Keen,<sup>110</sup> quoting Porter largely, says:

All physiologists know that the pumping action of the diaphragm is an important aid in the movement of blood from the abdomen into the chest. At the height of a strong inspiration the venous pressure in the chest may be more than 40 mms. lower than the venous pressure in the abdomen. I produced strong respiratory movements of the diaphragm by allowing the animal to breathe an atmosphere rich in carbon dioxide. The *diastolic* arterial pressure (which should always be the guide; the systolic pressure should not be used as the standard) was thereby increased 15 and even 30 mms.

In June, 1917, I successfully applied this new method to the treatment of wounded soldiers. In cases almost pulseless, cases in which all other means of raising the blood pressure had failed, the carbon dioxide respiration strengthened the pulse and raised the diastolic blood pressure 10 mms. This rise is of great value when the pressure is at the critical level.

*Postmortem Findings in Shock.* Moon and Crawford<sup>46</sup> give the following post-mortem changes as characteristic of shock: "widespread dilatation of capillaries and venules, with edema and capillary hemor-

rhages. These were most marked in the organs of respiration."

Wakeley and Buxton<sup>19</sup> say that

Postmortem, very little of importance is found in shock, the only reliable findings being in the central nervous system, where . . . chromatolysis occurs, commencing on the afferent side, and extending to the important vital nuclei. This is regarded as due to the nociceptive stimuli received wearing out the afferent nuclei first, extension being a secondary matter. Chromatolysis in the cerebellum has been shown to be very constant. Hence we see how profound is the benefit of sleep.

Moon<sup>16</sup> says that "Shock produces characteristic changes demonstrable by postmortem examination. These consist of marked capillary and venous congestion of the viscera, edema of lungs and mucosae, petechial hemorrhages in serous and mucous surfaces, and effusion of fluid into serous cavities."

#### SUMMARY

A very little reflection on the part of the reader will lead to the realization that, long as this review is, it represents in its present extent a virtual summarization of the available literature of the subject. It is probably not possible to condense further, i.e., to summarize, and at the same time to keep the review representative of the actual literature.

#### REFERENCES

The reading material reviewed in this article has been drawn from the (1) Library of the American Medical Association, Chicago; (2) American College of Surgeons Library, Chicago; (3) Library of the University of California, Berkeley, Calif.; (4) University of California Medical School Library, San Francisco; (5) Lane Medical Library, Stanford University Medical School, San Francisco; (6) Library of the Alameda County Medical Association, Alameda County Hospital, Oakland, Calif.; and (7) Private library of the author, Berkeley, Calif.

1. Webster's New International Dictionary (Unabridged) 1929.

2. MAWSON, X. O. S. The Roget Dictionary of Synonyms and Antonyms. N. Y., G. P. Putnam's Sons, 1931.
3. DORLAND, W. A. N. The American Illustrated Medical Dictionary. Phila., W. B. Saunders, 1927.
4. SCHORCHER, F. Shock, collapse and electrosurgery. *Deutsche Zeitsch. f. Chir.*, 243: 225 (May 14) 1934. Reviewed by the J. A. M. A., 103: 146 (July 14) 1934.
5. RUTHERFORD, A. G. The significance and management of shock. *West Virginia Med. Jour.*, 26: 26-28 (Jan.) 1930.
6. BICKHAM, W. S. Operative Surgery. Phila., W. B. Saunders, 1924, 1: 143 and 306-309.
7. WRIGHT, S. Applied Physiology. London, Oxford Medical Publications, 1928, pp. 290-300.
8. SHERRINGTON, C. S. The Integrative Action of the Nervous System. New Haven, Yale Univ. Press, 1911, pp. 240-247.
9. REHN, E. Operative Shock. *Internat. Clin.*, 2: 57-65 (June) 1934.
10. MANN, FRANK C. The peripheral origin of surgical shock. *Bull. Johns Hopkins Hosp.*, 25: 205-212 (July) 1914.
11. ATCHLEY, D. W. and LOEB, R. F. Dehydration and medical shock. *Med. Clin. N. Amer.*, 17: 1379-1391 (Mar.) 1934.
12. ORR, T. G. Hemorrhage and Traumatic Shock. Dean Lewis' Practice of Surgery, Hagerstown, Md., W. F. Prior Co., 1: 1-35 (chap. 9) 1928.
13. CANNON, W. B. Traumatic Shock, N. Y., D. Appleton Co., 1923, pp. 1-192.
14. MARSHALL, C. J. and PINEY, A. Textbook of Surgical Pathology. N. Y., D. Appleton, 1925, pp. 5-9.
15. CRILE, G. W. A Physical Interpretation of Shock. London, Oxford Press, 1921, pp. 1-208.
16. MOON, V. H. The shock syndrome in medicine and surgery. *Ann. Int. Med.*, 8: 1633-1648 (June) 1935.
17. CRILE, G. W. Surgical Shock, Harvey Lectures for 1907-1908, 3: 132-154. Phila., Lippincott Co., 1909.
18. MORTIMER, J. D. Shock, anesthesia, analgesia. *Med. Press and Circular*, 128: 515-517 (Dec. 25) 1929.
19. WAKELEY, C. P. G. and BUXTON, ST. J. D. Surgical Pathology. N. Y., Wm. Wood, 1929, pp. 859-862.
20. ROBERTSON, T. B. Principles of Biochemistry. Phila., Lea & Febiger, 1924, pp. 202, 207-208, 380-381.
21. WANGENSTEEN, O. H. Present concept of traumatic shock and its treatment. *Lancet*, 51: 711-718 (Dec.) 1931. Abstr. Sect., *Internat. Surg. Digest*, 13: 121-126 (Feb.) 1932.
22. HAMILTON, C. E. and ROTHSTEIN, E. Air embolism. *J. A. M. A.*, 104: 2226-2230 (June 22) 1935.
23. COCKE, C. H. Pleural shock. *Am. Rev. Tuberc.*, 31: 404-412 (Apr.) 1935.
24. TAYLOR, W. Postpartum hemorrhage and obstetric shock. *Clin. Jour.*, 64: 203-205 (May) 1935.
25. HARKINS, H. N. Shock due to freezing: 1. shift of body fluids and associated blood concentration changes. *Proc. Soc. Exper. Biol. and Med.*, 32: 432-434 (Dec.) 1934.
26. MILBERT, A. H. Infusion reactions with special reference to "speed shock." *Am. Jour. Surg.*, 26: 479-485 (Dec.) 1934.
27. HARKINS, H. N. Experimental burns: 1. The rate of fluid shift and its relation to the onset of shock in severe burns. *Arch. Surg.*, 31: 71-85 (July) 1935.
28. PALFREY, F. W. The Specialties in General Practice. Phila., W. B. Saunders, 1927, pp. 641-642, 654-655.
29. PEARL, F. L. Electric shock. *Arch. Surg.*, 27: 227-249 (Aug.) 1933.
30. WIGGERS, C. J. Physiology in Health and Disease. Phila., Lea & Febiger, 1934, pp. 699-706.
31. FRASER, A. J. Trauma, Disease, Compensation. Phila., F. A. Davis, 1930, p. 97.
32. SPILSBURY, SIR B. Some Medicolegal aspects of shock. *Lancet*, 2: 1038-1040 (Nov. 4) 1933.
33. MANN, F. C. and ESSEX, H. E. The present status of the problem of traumatic shock. *Am. Jour. Surg.*, 28: 160-165 (Apr.) 1935.
34. FRIEDLANDER, A. Hypotension. Baltimore, Williams & Wilkins, 1927, pp. 22-42.
35. HOLT, R. L., et al. A discussion on traumatic shock. *Brit. Med. Jour.*, 1: 792-793, (Apr. 13) 1935.
36. HEWLETT, A. W. Pathological Physiology of Internal Diseases. N. Y., D. Appleton, 1923, pp. 118-122.
37. McDOWALL, R. J. S. Clinical Physiology. N. Y., D. Appleton, 1927, pp. 123-130.
38. KNOEFEL, P. K. The nature of anesthetic shock and the value of premedication. *California and West. Med.*, 39: 344 (Nov.) 1933; Banerji, H. and Reid, C. (quoted by Knoefel). *Jour. Physiol.*, 78: 370, 1933.
39. JONES, W. C. Prophylaxis of shock. *Southern Med. Jour.*, 28: 166-168 (Feb.) 1935.
40. McDONAGH, J. E. R. Shock. *Med. Press and Circular*, 124: 27 (July 13) 1927; 47 (July 20) 1927; 70 (July 27) 1927; 89 (Aug. 3) 1927; 110 (Aug. 10) 1927.
41. HENDERSON, Y. Acapnia as a factor in post-operative shock, atelectasis and pneumonia. *J. A. M. A.*, 95: 572-575 (Aug. 23) 1930.
42. BLALOCK, A. A consideration of the causes and treatment of shock associated with injury to tissues. *Internat. Clin.*, 1: 144-161 (Mar.) 1933.
43. MOYNIHAN, SIR B. Complications of operations upon the stomach and intestines—shock. *Oxford Surg.*, 2: 643-648 (Pt. 2) 1928.
44. PORTER, W. T. Traumatic Shock, The Harvey Lectures, 13-14: 21-43, Phila., Lippincott Co., 1920.
45. ATCHLEY, D. W. Medical shock. *J. A. M. A.*, 95: 385-389 (Aug. 9) 1930.
46. MOON, V. H. and CRAWFORD, B. L. Shock syndrome in mercuric chloride poisoning. *Arch. Pathol.*, 15: 509-515 (Apr.) 1933.
47. MULLER, E. F., MYERS, C. N. and PETERSEN, W. F. The nature of shock symptoms occasionally following drugs or vaccines. *J. A. M. A.*, 88: 1128-1132 (Apr. 9) 1927.
48. FREEDMAN, H. J. Acute anaphylactic shock following intracutaneous test for sensitivity to horse

- serum; report of a fatal case. *New England Jour. Med.*, 212: 10 (Jan. 3) 1935.
49. BUERGER, L. Circulatory Disturbances of the Extremities. Phila., W. B. Saunders, 1924, pp. 62 and 526-527.
  50. DALE, H. H., LAIDLAW, P. P. and RICHARDS, A. N. The action of histamine—its bearing on traumatic toxemia as a factor in shock. *Med. Res. Com., Special Rep.* #26, London, 1919, pp. 8-15.
  51. MILLER, H. The mechanism of traumatic shock. *California and West. Med.*, 39: 344-345 (Nov.) 1933.
  - 51A. FREED, S. C. Quoted by Miller. *Proc. Soc. Exper. Biol. and Med.*, 30: 677 (Feb.) 1933.
  52. TURCK, F. B. Shock and fatigue with acute and chronic (cytost—anti-cytost) reaction. *Med. Rec.*, 100: 705 (Oct. 22) 1921.
  53. DE NITO, G. Blood pressure reducing hormones as cause of protein shock. *Deutsch. med. Wchnschr.*, 61: 339 (Mar. 1) 1935. Abstr. *J. A. M. A.*, 104: 1865 (May 18) 1935.
  54. CLARK, ALFRED. Surgical shock. *Glasgow Med. Jour.*, 5: 1-6 (Jan.) 1935.
  55. O'SHAUGHNESSY, L. and SLOME, D. Etiology of traumatic shock. *Brit. Jour. Surg.*, 22: 589-618 (Jan.) 1935.
  56. MILLER, I. D. Surgical shock. *Med. Jour. Australia*, 1: 522-523 (Apr. 27) 1935.
  57. ROOME, N. W. and WILSON, H. Experimental shock—the effects of extracts from traumatized limbs on the blood pressure. *Arch. Surg.*, 31: 361-370 (Sept.) 1935.
  58. PARSONS, W. and PHEMISTER, D. B. Hemorrhage and "shock" in traumatized limbs. *Surg., Gynec. and Obst.*, 51: 196-207 (Aug.) 1930.
  59. BLALOCK, A. Mechanism and treatment of experimental shock. *Arch. Surg.*, 15: 762-798 (Nov.) 1927.
  60. CUTLER, E. C. and SCOTT, J. M. Postoperative Complications, Graham's Surgical Diagnosis. Phila., W. B. Saunders, 1: 136-145, 1930.
  61. ROST, F. Pathological Physiology of Surgical Diseases (S. P. Riemann translation). Phila., Blakiston's, 1923, pp. 229-230.
  62. MALCOLM, J. D. On the condition of blood vessels during shock. *Lancet*, 1: 497-499 (Feb. 23) 1907.
  63. PETROFF, J. and FILATOV, A. et al. Experimental studies of hemolytic shock in blood transfusion. *Arch. f. klin. Chir.*, 181: 209 (Nov. 12) 1934; *J. A. M. A.*, 104: 430 (Feb. 2) 1935.
  64. WESSELKIN, P., LINDENBAUM, J., et al. Role of the central nervous system in pathogenesis of vascular disturbances in hemolytic shock. *Arch. f. klin. Chir.*, 181: 227 (Nov. 12) 1934; *J. A. M. A.*, 104: 430 (Feb. 2) 1935.
  65. MACFEE, W. F. and BALDRIDGE, R. R. Post-operative shock and shock-like conditions. *Ann. Surg.*, 91: 329-341, 1930. Reviewed in *Internat. Surg. Digest*, 9: 316-320 (May) 1930.
  66. KILDUFFE, R. A. Clinical Interpretation of Blood Examinations. Phila., Lea & Febiger, 1931, p. 587.
  67. AUB, J. C. and CUNNINGHAM, T. D. Studies in experimental traumatic shock—II. The oxygen content of the blood. *Am. Jour. Physiol.*, 54: 408-415 (Dec.) 1920.
  68. ELMAN, T. and COLE, W. H. Hemorrhage and shock as causes of death following acute portal obstruction. *Arch. Surg.*, 28: 1166-1175 (June) 1934.
  69. BAYLISS, W. M. and CANNON, W. B. Note on muscle injury in relation to shock, special report. Ser. #26, *Med. Res. Com.*, London, 1919, pp. 19-23.
  70. AUB, J. C. and WU, H. Studies in experimental traumatic shock—III. Chemical changes in the blood. *Am. Jour. Physiol.*, 54: 416-424 (Dec.) 1920.
  71. SCARPELLO, A. Experimental researches on glycogenic functioning of the liver in traumatic shock. *Rif. Med. Naples*, 46: 1198 (July 28) 1930. Abstr. *J. A. M. A.*, 95: 1460 (Nov. 8) 1930.
  72. CUTHBERTSON, D. P. Certain aspects of the metabolic response to injury. *Glasgow Med. Jour.*, 3: 41-56 (Feb.) 1934.
  73. AUB, J. C. Studies in experimental traumatic shock—I. The basal metabolism. *Am. Jour. Physiol.*, 54: 388-407 (Dec.) 1920.
  74. BLALOCK, A. Further studies with particular reference to the effects of hemorrhage. *Arch. Surg.*, 29: 837-857 (Nov.) 1934.
  75. MACLEOD, J. J. R. Physiology and Biochemistry in Modern Medicine. St. Louis, C. V. Mosby Co., 1926, pp. 514-525.
  76. RHODES, G. K. and MCKENNEY, C. Traumatic shock—its newer aspects and treatment. *California and West. Med.*, 33: 665-670 (Sept.) 1930.
  77. McDOWALL, R. J. S. Experimental shock, with special reference to anesthesia. *Brit. Med. Jour.*, 1: 690 (Apr. 22) 1933.
  78. WALLACE, C. S. Traumatic toxemia as a factor in shock. *Med. Res. Com.*, London, 1919, Special Rep. Ser. #26, pp. 3-8.
  79. ANDREWS, EDMUND. Surgical shock. *Northwest Med.*, 34: 122-126 (Apr.) 1935.
  80. CLARK, A. M. and CRUICKSHANK, R. Observations on the treatment of burns. *Lancet*, 1: 201-204 (Jan. 26) 1935.
  81. JOHNSON, C. A. Ephedrin sulphate in treatment of acute shock from trauma or hemorrhage. *J. A. M. A.*, 94: 1388-1390 (May 3) 1930.
  82. WOOD, P. M. Coramine in denarcotization and resuscitation. *Am. Jour. Surg.*, 22: 86-91 (Oct.) 1933.
  83. SOLIS-COHEN, S. and GITHENS, T. S. Pharmacotherapeutics. N. Y., D. Appleton, 1928, p. 1695 and index re: shock.
  84. HENDERSON, Y. Resuscitation. *J. A. M. A.*, 103: 834-837 (Sept. 15) 1934.
  85. SWINGLE, W. W., PFIFFNER, J. J., et al. The function of the adrenal cortical hormone and the cause of death from adrenal insufficiency. *Science*, 77: 58-64 (Jan. 13) 1933.
  86. FREEMAN, N. E. Cortin and traumatic shock. *Science*, 77: 211-212 (Feb. 24) 1933.
  87. BRITTON, S. W. and SILVETTE, H. Theories of cortico adrenal function. *Science*, 77: 366-368 (Apr. 14) 1933.
  88. SWINGLE, W. W. and PARKINS, W. M. A comparative study of the effect of trauma on healthy, vigorous dogs with and without adrenal glands.



- Am. Jour. Physiol.*, 111: 426-439 (Mar.) 1935.
89. DONAHUE, J. K. and PARKINS, W. M. Lipoid and hemorrhagic changes in adrenal cortex following traumatic shock. *Proc. Soc. Exper. Biol. and Med.*, 32: 1249-1253 (May) 1935.
  90. PARKINS, W. M., TAYLOR, A. R. and SWINGLE, W. W. A comparative study of sodium chloride, and blood pressure changes induced by adrenal insufficiency, etc. *Am. Jour. Physiol.*, 112: 581-590 (Aug. 1) 1935.
  91. HARROWER, H. *Practical Endocrinology*. Glendale, Calif., 1932, pp. 334 & 341-342.
  92. BLALOCK, A., WILSON, H., et al. Loss of protein from the blood stream. Effects of the injection of solution of pituitary and of epinephrine. *Arch. Surg.*, 26: 330-334 (Feb.) 1933.
  93. WANGENSTEEN, O. H. The recognition and treatment of surgical shock. *Surg., Gynec. and Obst.*, 54: 970-971 (June) 1932.
  94. BRANDSON, B. J. and HILLSMAN, J. A. Fluids in surgery. *Canad. Med. Assn. Jour.*, 26: 689-698 (June) 1932.
  95. PADGETT, E. C. and ORR, T. G. The insulin-glucose treatment of traumatic shock. *Surg., Gynec. and Obst.*, 46: 783-788 (June) 1928.
  96. SHELTON, H. J. The influence of physiologic research on modern surgery. *Virginia Med. Monthly*, 55: 790-796 (Feb.) 1929. *Abstr. Sect. Internat. Surg. Digest*, 7: 242-247 (Apr.) 1929.
  97. WADE, P. A. The present status of glucose-insulin in the treatment of shock. *Anesth. and Analg.*, 8: 298-301 (Sept.-Oct.) 1929.
  98. DJURICIC. Glucose et choc histaminique. *Compt. rend. Soc. de biol.*, 113: 432, 1933. *Physiologic Abstr.*, 19: 74 (Apr.) 1934.
  99. RANDALL, L. M. Shock in obstetrics. *J. A. M. A.*, 93: 845-847 (Sept. 14) 1929.
  100. HUFFMAN, L. D. Solution of acacia and NaCl in hemorrhage and shock. *J. A. M. A.*, 93: 1698-1702 (Nov. 30) 1929.
  101. GASSER, H. S. and ERLANGER, J. Studies in secondary traumatic shock; v. Restoration of the plasma volume and of the alkali reserve. *Am. Jour. Physiol.*, 50: 104-118; vi. Statistical study of the treatment of measured trauma with solutions of gum acacia and crystalloids. *Ibid.*, 119-148; vii. Note on the action of hypertonic gum acacia and glucose after hemorrhage. *Ibid.*, 149-156 (Oct.) 1919.
  102. WHITE, H. L. and ERLANGER, J. The effect on the composition of the blood of maintaining an increased blood volume by the intravenous injection of a hypertonic solution of gum acacia and glucose in normal asphyxiated and shocked dogs. *Am. Jour. Physiol.*, 54: 1-29 (Nov. 1) 1920.
  103. GOOD, R. W. and BOYER, B. E. Intravenous use of acacia solution in shock. *Jour. Med.*, 12: 630-636 (Feb.) 1932.
  104. FRAZIER, C. H. The modern treatment of surgical shock. *J. A. M. A.*, 105: 1731-1734 (Nov. 30) 1935.
  105. WENGER, H. L. Present conception and treatment of shock. *Am. Jour. Surg.*, 13: 307-310 (Aug.) 1931.
  106. HYMAN, H. T. and TOUROFF, A. S. W. Therapeutics of the intravenous drip. *J. A. M. A.*, 104: 446-451 (Feb. 9) 1935.
  107. The dangers from electrical shock. *J. A. M. A.*, Current Comment, 90: 1949 (June 16) 1928.
  108. PORTMANN, U. V. Observations on the use of diathermia for the prevention and treatment of surgical shock. *Arch. Phys. Ther., X-ray, Radium*, 9: 385-388 (Sept.) 1928.
  109. HITCHCOCK, H. H. and REYNOLDS, T. E. Shock treated by warmed air. *California and West. Med.*, 44: 98-99 (Feb.) 1936.
  110. KEEN, W. W. *The Treatment of War Wounds*. Phila., W. B. Saunders, 1918, pp. 22-36.
  111. Editorial. Shock, *J. A. M. A.*, 100: 46 (Jan. 7) 1933.
  112. Queries and Minor Notes: Use of dextrose intravenously in shock. *J. A. M. A.*, 107: 300-301 (July 25) 1936.
  113. *Am. Med. Assn. London Correspondent: Recent Work on Surgical Shock. J. A. M. A.*, 107: 725 (Aug. 29) 1936.



# RUPTURE OF BLADDER AND URETHRA\*

GEORGE F. CAHILL, M.D., F.A.C.S.

Associate Professor of Urology, College of Physicians and Surgeons, Columbia University; Associate Genito-urinary Surgeon, Presbyterian Hospital

NEW YORK

**I**N 9900 successive urologic admissions to the Squier Clinic, there were 20 cases of bladder injury and 27 renal injuries. In general, rupture of the bladder is an infrequent injury. The incidence has been reported to have occurred once in 5550 times, in over 300,000 surgical admissions to Bellevue Hospital. There is an apparent increase of bladder ruptures as evidenced in the recent literature.

Injuries to the bladder are of two types. The first is, rupture, due to sudden increased internal hydrostatic pressure and the second, puncture or perforation, due to the passage of some foreign object or adjacent bone.

Rupture of the bladder is the more frequent of the major injuries to the bladder. It occurs more often in males because of the greater hazard of exposure to traumatism. The highest proportion is that of Campbell with 3 females in 55 collected cases. In the Squier Clinic there were 3 females in 13 cases of rupture. The injury is most frequently seen in adult life but again from the literature, the proportion in childhood is increasing, due to the marked number of automobile accidents.

Rupture or bursting of the bladder can only occur when the bladder contains fluid. The more fluid it contains the more easily is it ruptured. The empty bladder is cushioned within the pelvis and well protected, therefore it is infrequently injured. The full bladder is mostly an abdominal viscus, belongs by attachments to the anterior wall and is exposed with and suffers from its traumatisms. The most common cause of rupture is some external violence as blows, crushes or falls. This is especially

so in those conditions that allow the bladder to become overdistended. Foremost among these is alcoholism. The partial anesthesia of alcohol allows the bladder to overfill, especially with the diuretic effect of alcohol, and again the partial anesthesia prevents the usual anticipation of trauma, so that there is no protective muscle contraction to protect the bladder. Other conditions that permit the normal bladder to overfill are psychopathic states, anesthesia, intensive mental occupation and social situations which prevent relief, not uncommon in automobile transportation. Pathological conditions that weaken the bladder wall, as atony, obstruction, tumors, or diverticuli and so forth, tend to make such bladders more prone to injury in minor traumatisms.

Spontaneous rupture has been reported. Rupture has occurred from muscular effort alone. It is thought that in these types, there must be some local weakness that makes these bladders more susceptible to trauma.

Rupture is frequently associated with pelvic or other fractures. Bartels found 65 bladder ruptures in 169 fracture cases. Campbell reported 25 cases of bladder injury in 166 cases of fracture of the pelvis. De Tarnowsky reported that only 5 per cent of his bladder ruptures were caused by or accompanied fractured pelvises. Boorstein found 6 ruptured bladders in 100 pelvic fractures at Fordham Hospital. In the 20 cases of bladder injury at the Squier Clinic there were 5 fractured pelvises. In respect to automobile accidents Bacon and LeCount, in a study of 383 automobile deaths, found 42 cases of fractured pelvis

\* From the Squier Clinic, Columbia-Presbyterian Medical Center, New York.

but only 3 with bladder ruptures. They estimate 0.7 per cent of automobile accidents are accompanied by bladder rupture.

Rupture may occur from sudden increased pressure from within the bladder. Wilhelm, Fillis and others have reported cases occurring at the time of cystoscopy. Ruptures have been reported as having occurred during litholopaxy. More recently cases of rupture have been reported by the explosion of gas generated by prostatic electrical revisions and there undoubtedly are more unreported, following the enthusiastic spread of this procedure. Self catheterization and simple bladder irrigations have been blamed for bladder rupture. Parmalee, Pridham and others have reported bladder rupture during pregnancy and Keenan, Roxas and Rustia have reported the accident during puerperium. Perforation or rupture of the bladder from extravescical pathological processes in organs in the vicinity have been reported, among which, was the unusual accident reported by Fillis, of a gravid uterus rupturing into the bladder.

#### MECHANISM

The bladder ruptures like any fluid sac subject to sudden pressure in one place or as any fluid sac that is moving and suddenly arrested by contact. There is an instantaneous shortening of the poles of the line of contact. The fluid, incompressible, immediately expands the circumference equatorially to the poles and the rupture occurs at its weakest point or most expansile portion. The usual trauma is to the anterior abdominal wall. The poles would be anteroposterior, the equatorial circumference vertical and the unsupported expansile portion, the dome or superior-posterior surface, and the rupture would occur at this point, intraperitoneally. This is the more frequent lesion. In falls on the buttocks, the full bladder acting like a bag will flatten vertically in its line of contact, and expanding its equatorial circumference, can only do so laterally or posteriorly, either intra- or extraperitone-

ally, where it is unsupported and will rupture at this area. Such ruptures or tears are widest at the equator and run towards the poles. It is possible, with a fractured pelvis, to have either a ruptured bladder or a perforated bladder from the fractured bone and diagnostically, before operation, such determination may be impossible.

In the cases of perforating wounds due to fracture of the pelvis, the pelvis is crushed, the rami are fractured and the pelvis again rolled between two opposing forces and the already fractured rami are forced into the pelvic tissues and through the bladder wall. Such forces may more easily injure a distended bladder, but do also injure a bladder comparatively empty. Crushes separating the pubis not infrequently tear the tissues down through the sphincteric portion of the bladder.

#### SYMPTOMS

The symptoms are first those of shock. Campbell reported that one-fourth of the cases at Bellevue Hospital were in shock on admission. The shock may be slight or severe, and with the shock frequently occur the signs suggestive of hemorrhage. Local pain and tenderness in the lower abdomen are usually present. In alcoholics or in psychopathic cases little complaint may be given concerning their local reactions. Increase of local tenderness progresses with the symptoms of infection and with peritonitis, if intraperitoneal. The literature has many extraordinary cases where these signs have been overlooked. There is frequently a marked desire to void, with inability to produce urine or at most a few drops of blood. Gastrointestinal symptoms may be absent until peritonitis develops. Frequently the tenderness present with a fractured pelvis may mask or cause to be unrecognized the true abdominal tenderness. It has not been unusual to find the attention focused upon some associated injury or fracture and the abdominal symptoms neglected until all are predominant.

The symptoms may be all those of a fractured pelvis with pain, inability to walk or to use the lower limbs without

stillation of a measured amount of fluid with inability to recover the entire amount may suggest a rupture. A recently seen

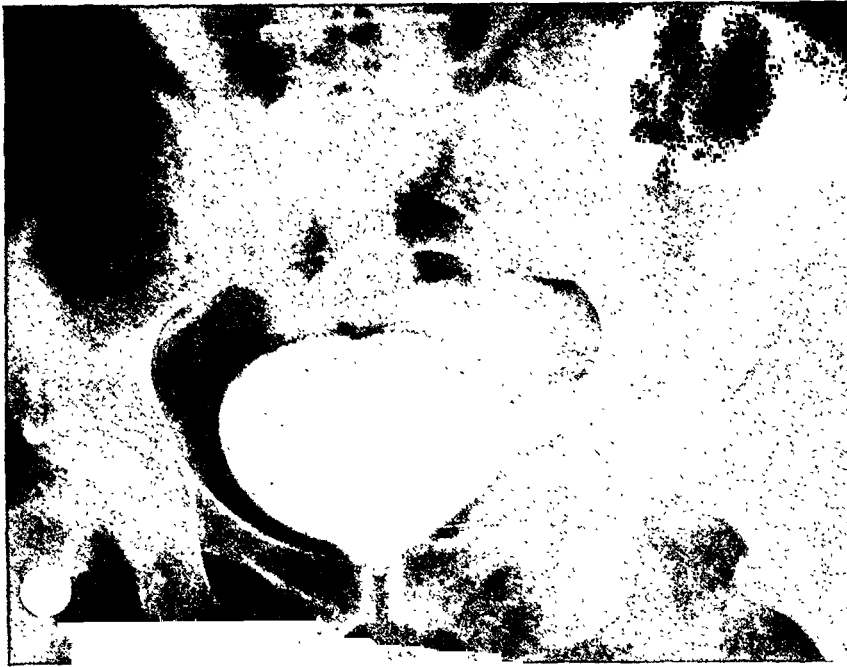


FIG. 1. Intraperitoneal and extraperitoneal diffusion of iodide solution in a bladder rupture associated with a fracture of the left side of the pubic arch in a thirty-four year old female.

pain, and the desire to void may be present only to a slight degree.

#### DIAGNOSIS

In any case with a clear history of injury and with the sensation of a sudden "giving way" in the abdomen, with inability to void, there is a strong possibility of rupture of the bladder. Frequently such a history is not obtainable. Examination shows abdominal distention in over 60 per cent of the cases. Free fluid in the abdomen is demonstrable in 30 per cent of the cases. Hematoma may be present somewhere in the region of the pelvis. The most commonly employed procedure for diagnosis has been catheterization. No urine or a small amount of bloody urine may be obtained. Deduction may be difficult, if the catheter eye is plugged with blood which frequently may be traumatic from the catheterization. Occasionally a catheter penetrating through an intraperitoneal rupture will drain a large amount of bloody fluid. In-

rupture occurred, in which the exact amount of fluid was recovered several times.

Cystoscopy has been used to demonstrate rupture of the bladder. Definite determination often has been impossible on account of bleeding or the inability to keep the bladder sufficiently well distended to visualize the whole. Both catheterization, injection and cystoscopy add additional trauma and increase the incidence of infection. If used, these should immediately precede exploration.

Roentgenograms of iodide solutions injected into the bladder will give a shadow of the penetration of the iodide outside the bladder. Vaughn and Rudnick introduced air in 50 to 200 c.c. amounts, followed by x-ray pictures for the same purpose. The air has been shown, in cases, to ascend under the diaphragm, definitely proving intraperitoneal rupture, but may confuse a possible intestinal rupture, unless its absence has been previously confirmed. Such injections occupy the same position

as cystoscopy. They increase the incidence of and add to the spread of infection.

Of most value have been the cystograms

venous urographic study as early as possible. In fractures of the pelvis, however, the passage of clear, normal voided urine



FIG. 2. A secretory cystogram showing a fracture of the four rami of the pubis with intact bladder with small cellules and the bladder displaced upward by pelvic tissue diffuse hematoma. Injury to left kidney with fractures treated by transfusions and rest and care of fractures. Recovery followed without operation.

obtained from injected intravenous pyelographic solutions. They lessen the most serious risk, that of infection. It is not always possible to delay operative intervention in the more serious injuries, so that a secretory cystogram may be obtained. Such injured should be given a transfusion followed by operative exploration which should reveal the injury. However, the larger number of cases allows such procedure and in these, it demonstrates the urinary extravasation as well as traumatic lesions of the kidney and ureter.

A preliminary x-ray study of the chest and abdomen will disclose associated fractures or the possibility of other visceral injuries. When there is considered the marked frequency of a bladder injury to be associated with a fractured pelvis all fractures of the pelvis should have intra-

in any quantity, has been considered as ruling out the possibility of bladder injury.

Early blood examinations are the index of the degree of hemorrhage; later examinations are an index of the severity of the infection. Other laboratory examinations, except the demonstration of blood in the urine have been of no special significance.

#### TREATMENT

Having established the probability of the diagnosis, immediate operation is essential. If shock is present, the condition has been best improved by transfusion, associated with heat and stimulants. There is no special choice of anesthesia but low blood pressure may contraindicate spinal. If in an alcoholic, a preliminary gastric lavage may prevent a later insufflation pneumonia.

Intraperitoneal exploration is necessary in most cases. If intraperitoneal involvement is present, the fluid is aspirated. The

tory pyelographic studies may be of great importance.

Perivesical hematoma or extravasations



FIG. 3. A suspected bladder injury with abdominal blow and left flank stab wound. A secretory cystogram shows an intact bladder but a huge blood clot that caused urinary retention. The bleeding was from the left kidney.

vesical tear is located after exploration has disclosed no other visceral injuries. The tear is closed with special attention to peritonealizing the closure. After complete aspiration of all the intraperitoneal fluid, the peritoneum is closed, if the case is early. If so, then ample aspiration suprapubic drainage of the bladder with a wide tube is provided. This drainage, we find keeps the bladder dry and prevents dilatation and leakage.

Associated injuries to other abdominal viscera may occur. The more frequently seen have been to the intestine. Next in order are injuries to the spleen, the kidneys and the liver. Correction of these injuries, if possible, is performed at the time of exploration. With the presence of blood in the urine and a ruptured bladder, there is still a possibility of renal injury. To establish this particular point the intravenous secre-

are widely drained through the suprapubic prevesical opening. If the case is seen late and evidence of local peritonitis is present, drainage of the intraperitoneal area suprapubically should be attempted with a walling off of the peritoneal cavity with the omentum.

If the injury and extravasation are extraperitoneal, the peritoneum, if opened, is rapidly closed and then the procedure is modified accordingly, to the area involved. Penetrating wounds from fractured bones are frequently small, but require suture, because they bleed annoyingly. Occasionally the bone remains penetrating into the bladder and removal may be difficult. It has been necessary to remove the projections or spicules before the bladder can be freed from empalement. It may be wise in such conditions to endeavor to close such bladders completely and drain with an

indwelling catheter. From past experiences, urine draining across fractured, exposed bone, has been followed by a very serious osteomyelitis and marked absorption of the calcium of the bone.

Extensive lacerations of the bladder and pelvic tissue may occur in which complete repair may be unwise on account of the precarious condition of the patient. It is safer to control the hemorrhage, provide wide drainage and restore vitality with transfusions and so forth.

Injuries involving the floor of the bladder and with extravasation into the deep pelvis, may be drained perineally as well as suprapubically. Some writers, Berry for instance, preferred perineal section and drainage with his cases of ruptured bladder. In the series of cases reported by Campbell, external urethrotomy with drainage, was attempted four times with no recoveries.

#### SURGICAL PATHOLOGY

The urinary extravasation may extend into the subcutaneous tissues or cause a marked edema of those tissues and the abdominal muscles. Extraperitoneal extravasations cause early, marked reddish edema of the perivesicular tissues which later change into grayish or grayish red tissues that do not reflect light. Localized collections of watery abscesses may occur. Marked perivesicular hemorrhage may obscure the bladder musculature so that recognition of the bladder may be difficult. Crepitation is not uncommonly present. The infection may or may not be from the gas bacillus of Welch but such infections have occurred, especially in the perforating pelvic injuries.

The most frequent site of rupture is on the summit of the posterior surface. It is usually irregular, may be oblique, longitudinal or transverse. The contraction of the bladder may change the apparent shape of the opening. The locations of the sites in Campbell's report were dome 37, lateral wall 4, floor 3, vesical outlet 4 and posterior wall 1.

The perforating injuries from bone are usually on the lateral anterior wall near the vesical outlet and are small. Profuse hematomas are often present because of the vascularity of this area. Similar hematomas occur when the bladder neck has been torn with a pubic separation.

Peritonitis, if present, is more marked in the pelvis and occurs with high frequency as reported in the Bellevue series, having occurred in 23 of 32 intraperitoneal ruptures, due to tardy recognition of the condition.

When the rupture has been associated with previous infection or some previous pathology, the extension of the infection has been marked due to the explosive action of the fluid penetrating throughout the peritoneum. In 3 cases of rupture of diverticuli and in one associated with bladder tumor at the Squier Clinic, a fatal, rapid, diffuse peritonitis occurred in all.

#### COMPLICATIONS AND SEQUELS

The complications are mainly shock, hemorrhage and infection.

Primary shock and hemorrhage may be rapidly fatal. This is the not infrequent rapid ending in severe pelvic crushing. In some cases in which the shock and hemorrhage have not been severe, an early marked infection develops in the extravasated tissues, with a sepsis and death within several days.

In alcoholics a bronchial or aspiration pneumonia has not been infrequent, especially if vomiting occurred during the administration of the anesthetic.

The association of other injuries, as fractures, lacerations or injuries to other viscera add many complicating factors to the treatment.

Acute osteomyelitis may develop in a fractured pelvis, especially when associated with a urinary sinus. In one case the entire pubic arch was absorbed before the patient died of exhaustion.

Gas bacillus infection may prove rapidly fatal and the extension has progressed as high up as the thoracic area.

Peritonitis has been reported to have occurred in over 50 per cent of the cases.

Postoperative evisceration has occurred in alcoholics and psychopathic cases and in these cases reported hopeless.

Slow healing of the suprapubic sinus is frequent, especially in extraperitoneal ruptures. Some of these cases are due to scar contraction of the injured area, near the vesical neck and require surgical procedures for closure. Residual intrapelvic abscess is not infrequent and is often due to retained slough or insufficiently drained fascial plane areas. Vesical calculi have been reported to have occurred following bladder trauma. Renal infections have been not uncommon with the infection stage and deaths have been reported from subsequent renal deficiency.

#### MORTALITY

A historical review has shown a definite but gradual lowering of the mortality rate. In a series of cases reported by Besley up to 1907, there was a mortality of 78 per cent. From 1927 to 1929, in 13 cases admitted to the same hospital there was a mortality of 61 per cent. Rouvillers and Ferron, in 1931 tabulated a mortality of 49 per cent in a review from the literature of 278 cases. Before 1894, the mortality in intraperitoneal ruptures was 60.9 per cent, from 1894 to 1921 it was 23.9 per cent. Hagenbrück in 35 cases occurring from 1905 to 1925, reported a mortality of 53 per cent. De Tarnowsky in 1930 had a mortality of 45 per cent in 50 cases. Campbell in a review of all services at Bellevue, found among 55 cases that the mortality was 68 per cent among the intraperitoneal ruptures and 40 per cent among the extraperitoneal. White in 1933 estimated the mortality then as 40 per cent. In 20 cases of bladder rupture and perforation at the Squier Clinic since 1929, the mortality was 30 per cent.

Intraperitoneal ruptures have had the higher death rate. This has been largely due to the failure to diagnose the condition sufficiently early so that operation was

not performed in the early period of contamination and before infection was established. The marked seriousness of disseminated contamination in the peritoneal cavity and its prevention by early interference has been so dramatically established in the results established by early recognition and correction in perforating gastric or duodenal ulcer. In bladder rupture similar facts have been well shown by various writers. Negley, in 1927 showed that the mortality in operations performed in the first twelve hours was but 11 per cent, whereas in the second twelve hours it had risen to 22 per cent and by the second day to 43 per cent. Similar tabulations have been reported by Rouvillers and Ferron, and de Tarnowsky. The inescapable conclusion from these facts is that most of the bladder ruptures are seen by those who either are indifferent to the seriousness of the condition, which is a major catastrophe of the abdomen requiring immediate interference, or else they are unaware of the symptoms and signs necessary for the diagnosis.

Extraperitoneal ruptures are considered less dangerous, if uncomplicated. The comparatively less serious extraperitoneal infection, its better localization and with better natural defensive barriers offer a less serious prognosis. Extraperitoneal ruptures in the presence of complications, especially marked hemorrhage and severe crushing injuries to the pelvis, present cases of injury second to none in severity, and with the multiplicity of lesions the mortality rises rapidly.

Most writers in stressing the importance of early diagnosis and operation believe the mortality could be reduced to 20 per cent. The low limit must necessarily be estimated by the degree of general injury in which bladder rupture often plays an important part.

#### RUPTURE OF THE URETHRA

The urethra may be ruptured by traumatism from within or without. Lack of skill and gentleness in instrumentation is



the usual cause of injuries from within. Less rarely, self-inflicted injuries occur in psychopathic states. The first symptom is continuous bleeding from the urethra, independent of voiding. Control of the bleeding in the milder injuries is accomplished best by pressure upon the corpora spongiosum or perineum, although if accompanied by urinary difficulty an indwelling catheter may be necessary to prevent extravasation. If the bleeding is uncontrolled and extravasation is beginning, as shown by perineal tenderness and swelling, for it is the bulb which is more frequently injured, a perineal section and drainage may be necessary. Rarely, the urethra may be ruptured by injection of solutions. Such ruptures often cause severe phlegmons, which in healing cause marked stricture formation. Among the most severe, have been those cases in which liquid paraffin has been injected for lubrication into the urethra, rupturing it and extravasating through the corpora.

The usual causes of urethral rupture are blows or falls on the perineum. The urethra may be completely or partially severed by a crush against the pubic bone or may be lacerated by the sharp end of a fractured pelvis. The more frequent injury is the straddle; in falling astride a fence, or bar, or saddle horn, or rail, or some narrow object, the full force of the fall being borne directly on the perineum. A similar traumatism is described by O'Connor from a blow to the perineum by a tilting manhole cover.

The tear of the urethra may be transverse, oblique or longitudinal. It may involve any one of the following parts: pendulous, bulbous portion anterior to the triangular ligament and the membrorprostatic portion posterior to the triangular ligament. Mainly it is extrapelvic or intrapelvic. The urethra may be completely torn from the bladder. This has occurred with complete, wide separation of the pubic arch. A similar injury occurred in a case admitted to the Squier Clinic in which a complete separation of the urethra from

the bladder occurred during a forceps delivery. Recovery followed suprapubic drainage and later urethral anastomosis.

Peacock and Hain collected 200 cases of urethral rupture and found that 8 per cent were due to straddle falls, 12 per cent to perineal blows and 4 per cent to crushes. They found 71 per cent of their cases of traumatic ruptured urethras were associated with pelvic fractures. From their report they concluded that of all cases of fractured pelvis less than 10 per cent have ruptured urethras. Young quotes Baer in estimating that the urethra is wounded in not over 1 or 2 per cent of pelvic fractures.

The first symptoms of rupture of the urethra are pain and urethral hemorrhage. This is followed by hematoma, if the rupture is in front of the triangular ligament, frequently with inability to void. The bleeding is from the meatus and separate from any act of voiding. If the injury is posterior to the triangular ligament, there may be little or no meatal bleeding, but a deep perineal hematoma may be present. Often with intrapelvic injuries the hemorrhage may be all through the perivesical tissues and perineal ecchymosis may develop later.

There is usually not the marked desire to void seen in bladder injuries. Attempts to void, however, are very painful due most likely to extravasation during the act. Marked increase in the tumefaction present may occur immediately following such attempts. The retention of urine is frequently so marked that the distended bladder may be visible or palpable above the pubis.

When extravasation occurs, the course is dependent upon the site of the rupture. Extravasation superficial to the triangular ligament will be limited by the attachment of Colles's fascia and will extend into the perineum, the scrotum, and upwards to the inguinal regions and abdomen. When the site of the injury is deeper inside the triangular ligament, the extravasation extends about the vesical neck, lateral to the bladder and into the prevesical spaces.

The diagnosis of urethral rupture may be obscured early, in partial ruptures, but as a rule the lesion becomes evident. In the beginning it may be confused with bladder rupture, but later, bladder distention rules out rupture of that organ.

Attempts at urethral catheterization have been widely used as a diagnostic procedure. Such has been condemned by White, Hansen and others, as producing further hemorrhage and introducing infection.

The surgical indications are diversion of urine, prevent or drain infection or extravasation and repair the tear. Hansen recommends observant treatment in the milder cases but for all others an immediate suprapubic cystotomy and later suture of the urethra without a residual catheter. Wheeler believes that all cases should have an immediate suprapubic drainage. He supplements this procedure with retrograde catheterization and then perineal exposure and repair.

In our experience the suprapubic drainage accompanied by continuous aspiration has been most adequate for the urinary diversion. In the presence of urinary extravasation, wide incision and drainage is necessary. The repair of the urethra is done at times with difficulty. Localization of the urethra is best by retrograde catheterization. The interlocking sounds as suggested by G. G. Davis facilitate this maneuver. Early union of the urethra is desired and if the condition of the patient permits should be done at the same sitting. There has been considerable controversy as to whether the urethral repair should be followed by a retention catheter. Some surgeons condemn it because of the constant association with infection. Experience has shown the operative surgical repair is facilitated by the catheter but it should then be removed and the aspiration suprapubic suction drainage used to divert the urine until healing has taken place. Repair in a perineum may not be possible when extravasation and infection are marked. Such cases are best treated

by wide incision, extirpation of as much necrotic tissue as seems expedient, and as soon as healing has commenced a repair of the severed urethra attempted. These cases are frequently followed by severe intractable urethral strictures necessitating long periods of urethral dilatation. Plastic repair may be necessary for urethral defects or for undilatable strictures. However, these are more successful if undertaken after the inflammatory reaction has subsided.

Impotence is not infrequent after urethral injuries and plays an important place in those cases under settlement for compensation disabilities. The impotence has been described by Peacock and Hain to be due to lesions of the sympathetic fibers with the urethra, injured at the site of rupture.

The prognosis of urethral rupture is better than vesical rupture as far as life recovery is concerned. Hansen reports a mortality of 29 per cent in 135 cases, but if the hopelessly injured with other involved organs were excluded the mortality was 14 per cent. The local recovery or perfect anatomical healing is poor. Less than 10 per cent recover without the necessity of dilations. Most require long and persistent postoperative treatment. Satisfactory functional recovery depends on early diagnosis and prompt and intelligent surgical intervention.

#### SUMMARY

Cases of bladder rupture are increasing with the increase of automobile accidents. The usual cause of ruptured bladder is external traumatism to an overfilled bladder, not uncommonly seen in alcoholics. An increasing proportion is associated with fractured pelvis. Occasionally the rupture is secondary to medical manipulations. Intraperitoneal ruptures are more frequent than extraperitoneal ones.

Symptoms are shock, abdominal pain and tenderness with marked desire but inability to void.

Diagnosis is best made by intravenous pyelography and cystograms showing the diffused dye outside the bladder. This procedure lessens the danger of infection.

Rupture of the bladder is a major abdominal catastrophe and requires immediate surgical intervention. Closure of the tear with wide drainage and aspiration is recommended.

Complications are shock, hemorrhage and infection.

Mortality has been steadily declining, from 78 per cent up to 1907, to 30 per cent in the tabulation of the cases at the Squier Clinic. This percentage might be still lower if the bladder ruptures could be isolated from the high percentage of general injuries with which they are associated.

The urethra may be ruptured either from within or without. Rupture from without is the more usual and is generally due to a fall on the perineum. It frequently occurs with fracture of the pelvis.

Symptoms are those of pain, hemorrhage and urinary extravasation.

Drainage of the extravasated area followed by repair of the urethral tear gives the best results. Use of an indwelling catheter increases the danger of infection.

All cases require long after-treatment with sounds to dilate the subsequent stricture.

Impotence frequently occurs following this injury.

#### REFERENCES

- BACON, L. H. and LE COUNT, E. R. *Arch. Surg.*, 18: 769, 1929.  
 BARTELS, M. *Arch. f. klin. Chir.*, 22: 519, 1878.  
 BERRY, N. H. *Can. Med. Assn. Jour.*, 22: 475, 1930.  
 BESLEY, F. A. *Surg. Gynec. and Obst.*, 44: 372, 1927.  
 CAMPBELL, M. F. *Surg. Gynec. and Obst.*, 49: 540, 1929.  
 CROSBIE, A. H. *Jour. Urol.*, 12: 431, 1924.  
 DAVIS, G. G. *Surg. Gynec. and Obst.*, 50: 105, 1930.  
 DE TARNOWSKY, G. *J. A. M. A.*, 95: 476, 1930.  
 FILLIS, B. C. *Jour. Urol.*, 29: 601, 1933.  
 HAINES, C. *Jour. Urol.*, 29: 285, 1929.  
 HANSON, J. *Ergebn. d. Chir.*, 27: 470, 1934.  
 NEGLEY, J. C. *Jour. Urol.*, 18: 207, 1927.  
 PEACOCK, A. H. and HAIN, F. F. *Jour. Urol.*, 15: 561, 1926.  
 PRIDHAM, F. C. *Brit. Med. Jour.*, 2: 494, 1927.  
 ROUVILLOIS, H. *Encyclopedie Francaise d'Urologie*. Vol. 4, 1921, p. 89.  
 ROXAS, B. and RUSTIA, G. *Jour. Phil. Isl. Med. Assn.*, 4: 608, 1924.  
 STIRLING, M. C. and BELT, N. J. *A. M. A.*, 92: 2006, 1929.  
 VAUGHN, R. T. and RUDNICK, D. F. *J. A. M. A.*, 83: 9, 1924.  
 WHEELER, W. I. *Brit. Jour. Urol.*, 1: 126, 1929.  
 WHITE, E. W. *Jour. Urol.*, 29: 295, 1933.  
 WILHELM, *Jour. Urol.*, 22: 555, 1929.  
 YOUNG, H. H. *Practice of Urology*, Phila., W. B. Saunders & Co., 1926.



# SUBACUTE PERFORATIONS OF PEPTIC ULCERS\*

ARTHUR M. DICKINSON, M.D., F.A.C.S.

Attending Surgeon, Memorial and Child's Hospitals

ALBANY, N. Y.

THE author's interest in this problem was aroused by a review of his diagnostic errors for the past two years and finding 4 cases in which he failed to recognize the existence of a subacute perforation of a peptic ulcer in the early stages. These patients all recovered and the diagnosis was subsequently made either by radiography or operation.

Most of us have been taught the clinical picture of the classical acute perforation of peptic ulcers; we also are familiar with the hyperacute or fulminating type of perforation. On the other hand, many of us have not realized that subacute or minor perforations do occur with considerable frequency and are accompanied by definite findings. Singer and Vaughan<sup>1</sup> were the first in this country to call attention to these subacute perforations and in 1930 gave them the name of "formes frustes." Since then reports of such cases have appeared by Eiskamp and Blaisdell,<sup>2</sup> Habein<sup>3</sup> and several others. In 1932, Singer and Vaughan<sup>4</sup> reported a further study of this problem.

Peptic ulcer is a fairly common condition; postmortem records show that ulcers of the stomach or duodenum are found in 4.5 per cent of individuals coming to autopsy. They are more common in males than females, the ratio being about 4:1. Statistics vary as to the occurrence in the various age groups but the ages thirty to fifty years furnish about 50 per cent of the ulcer cases.

Perforation is to be expected in about 10 per cent of the cases of peptic ulcer. Eliason and Ebeling<sup>5</sup> made a careful study of 729 cases of peptic ulcer. They found that approximately 75 per cent of the ulcers were located in the duodenum and

25 per cent in the stomach. In this series, 11 per cent of the duodenal ulcers and 7.6 per cent of the gastric ulcers perforated. This would give an average of about 10 per cent perforations for the entire group.

Commonly perforation of a peptic ulcer takes place into the general peritoneal cavity although it may occur into a walled off area or into the lesser omental bursa or into neighboring organs. Shelley,<sup>6</sup> in a study of 82 cases of perforation at St. Luke's Hospital in New York, found that perforation into the free peritoneal cavity occurred in about 62 per cent of the cases; in 30 per cent the perforation was sealed or walled off and in about 8 per cent the perforation was retroperitoneal or into the pancreas.

Some perforations occur in the absence of any history suggesting previous ulcer symptoms. The great majority of the perforated cases, however, do give a long standing history of indigestion. Gilmour and Saint<sup>7</sup> in a study of 64 cases of acute perforation, state that in 88 per cent there was a history of indigestion for years. In the series presented by Shelley<sup>6</sup> there was a history of indigestion of more than two months duration in 91 per cent of the cases. Eliason and Ebeling,<sup>5</sup> in their extensive survey, found an absence of such a history in 18 per cent of the reported cases. Personal experience would seem to indicate however, that perseverance in searching for apparently minor details would be rewarded by a suggestive ulcer history in close to 100 per cent of cases. So frequently, the patient with a perforated ulcer is quite ill and the condition so obvious that we or our assistants do not feel justified in spending sufficient time to elicit these details.

\* From the Surgical Service of the Memorial Hospital, Albany, N. Y.

The acute perforation of a peptic ulcer is characterised by a fairly definite clinical picture. In the great majority of instances, the patient will give a history that his ulcer has been more active than usual in the past few days; he will tell you that there has been more pain and perhaps some vomiting. With the onset of acute perforation, there is commonly severe agonizing pain, located in the epigastric region. The pain is generally of the steady boring or burning type; the patient holds himself in a fixed position, lest any movement increase the severity of the pain. Occasionally we do see the exceptions to this however and the patient turns and twists with a colicky type of pain. About one-half of the patients with an acute perforation vomit with the onset and continue to retch and gag long after the stomach is emptied. The shock of the perforation is often so severe that the patient becomes cold and clammy and beads of perspiration stand out on the forehead. As one approaches such a patient, his pallor is noted, there may be some cyanosis of the lips and he really looks sick. In the early stages, there is tenderness in the subcostal angle.

Livingston in his monumental work "A Clinical Study of the Abdominal Cavity and Peritoneum," has clearly pointed out the reason why pain from a perforated ulcer is always referred to a definite location. Usually, there is spasm of the abdominal muscles amounting to almost board-like rigidity. This will be more marked about the level of the umbilicus in the early stages, before widespread peritoneal involvement occurs. There are other signs of acute perforation but these only are cited for comparison with the signs found in the subacute perforation. As involvement of the peritoneal cavity increases, the symptoms and physical signs rapidly become those of a general peritonitis and usually death ensues unless surgical intervention is successfully accomplished.

In the hyperacute or fulminating type of case, the symptoms are similar to those of the acute perforation but more severe and

widespread; general peritoneal involvement is rapid and collapse occurs promptly. The duration of the process is measured in hours rather than by days as in the acute type.

Subacute or minor perforation is a much milder affair than the acute. Usually the actual perforation is preceded by a period of increased ulcer activity; often the perforation itself is considered to be merely a manifestation of the increase of activity. There may be pain and tenderness in the epigastrium; there is absence of the severe pain and shock seen with acute perforation. There may be vomiting but this is usually of short duration and often by the time the physician sees the patient, he finds the latter taking fluids by mouth with no apparent discomfort. Within a few hours after the onset, the patient appears quite comfortable and exactly what has occurred may be a matter of speculation. A great percentage of these minor perforations go on to spontaneous recovery and the patient is apparently completely well in three to four days. That there has been a subacute perforation may be proved by the finding of free gas in the peritoneal cavity by fluoroscopic examination in the early stages; later the diagnosis may be established by operation or radiography. The mildness of the symptoms following minor perforations may be explained upon the basis of a small amount of gastric contents at the time, a limited amount of leakage and the ability of the peritoneal surfaces to cope with such foreign material. It is true that many of the minor perforations are promptly plugged by mucus or sealed by omentum; this does not occur in all instances however; occasionally subsequent radiography or operation demonstrates that the perforation is still patent. The size and position of the ulcer apparently have little to do with the severity of the symptoms resulting from perforation. Waltman Walters, in discussing Habein's<sup>3</sup> case, says, "The size, position and extent of the inflammation is often out of all proportion to the duration and de-

gree of the symptoms." Shelly<sup>6</sup> in commenting on this question states, "The size of the perforation and the amount of induration apparently bore no relation to the history and physical findings."

Subacute perforations of peptic ulcers are very commonly mistaken for other conditions. Singer and Vaughan<sup>1</sup> state that about 2 of 3 of these cases are erroneously diagnosed when first admitted to hospital. The symptoms are quite frequently thought to be due to gastritis, pleurisy, central pneumonia, coronary heart disease, gall-bladder disease, etc.

From the literature on peptic ulcer one gathers the impression that subacute perforations are relatively infrequent. The fact is, that they are frequent enough but we fail to recognize them. In their study of this problem, Singer and Vaughan<sup>1</sup> found that 14 cases of subacute perforation in comparison to 12 cases of acute perforation, were admitted during a three months period at Cook County Hospital. This would seem to indicate that the frequency of these two types of perforation is about equal.

Treatment of the acute perforation of a peptic ulcer is based upon immediate operation at which time the ulcer is excised or destroyed by cautery, the ulcer bearing area inverted and the suture line covered with a tab of omentum; in some hands, a gastroenterostomy is also done at the same time. Most surgeons feel that acute perforations are surgical emergencies and that unless operated upon promptly, patients soon become moribund. Without operation at least 85 per cent of these patients will die.

What then is to be the method of treatment of the subacute perforation? To be logical, the same method is indicated. On the other hand, it is an established fact that a very considerable percentage of the patients with subacute perforations do recover without the benefit of surgery. Singer and Vaughan<sup>4</sup> reported a series of 40 such cases which occurred in a period of eighteen months at the Cook County

Hospital. However, there are some instances in which surgery is positively indicated if the patient is to recover. Where the perforation closes spontaneously and there is mild peritoneal reaction, probably the patient will recover without surgery. The crux of the dilemma is to decide if the perforation is closed or not. This may be almost impossible. A safe rule is to operate upon all cases within the first twenty-four hours, where a diagnosis of perforation is established. If more than twenty-four hours has elapsed since perforation occurred and the process is apparently quiescent, operation should be deferred for it will only stir up infection and lead possibly to a fatal peritonitis. If, on the other hand, there is evidence of spreading peritoneal irritation, operation is indicated even though more than twenty-four hours has elapsed since perforation.

#### CASE REPORTS

CASE 1. H. J., male aged forty-seven years, entered the hospital complaining of nausea and vomiting of forty-eight hours duration. One hour before admission he had been seized with a severe pain in the epigastrium which doubled him up and had continued since.

There was a history of bilious attacks, consisting of nausea and vomiting, occurring frequently for several years; no pain had been associated with these attacks.

Examination showed a thin individual who was apparently not in great pain. The temperature was 98.4, pulse rate 52, respirations 18. The chest was negative. The abdomen was scaphoid in shape; there was moderate rigidity throughout with tenderness in the epigastrium. At this time the white blood count was 12,240 with 38 per cent segmented forms, 43 per cent stab cells, 4 per cent juvenile forms and 15 per cent small lymphocytes. A waiting policy was adopted.

Eight hours later, the temperature was 100.2, pulse rate 80 and respirations 20. The patient was complaining of pain in the right shoulder blade but appeared comfortable; he volunteered the information that he felt much better. There had been no further vomiting. There appeared to be some retraction of the abdominal muscles although they moved quite freely with respira-

tion. Some spasm and rigidity of both sides of the abdomen was noted above the level of the umbilicus and there was slight tenderness in the right upper quadrant. Auscultation of the abdomen revealed no peristaltic sounds. At the end of another eight hour period, the temperature had increased to 101. F., the pulse rate was 82 and the respirations 20. The patient stated he felt much better although examination of the abdomen showed little change.

At the end of the twenty-four hour period, the temperature and pulse were as before but there was a very marked subsidence of the abdominal signs. At the end of forty-eight hours the patient showed further improvement and was taking fluids freely by mouth without apparent distress. At the end of seventy-two hours, the patient stated that he was "all right." His temperature was 98.6 F., pulse rate 70 and respirations 18. Nothing abnormal was noted upon examination, except slight tenderness in the epigastrium. Treatment from that time on consisted of the usual ulcer regime. Fourteen days after admission, a gastrointestinal study showed definite ulceration of the duodenum with considerable pyloric spasm and retention of the meal.

CASE II. J. M., male, aged forty-four years, entered the hospital complaining of severe upper abdominal pain of four hours duration, accompanied by retching. He stated that he had suffered with indigestion for more than one year, often had severe attacks and occasionally vomited blood in an attack. To him the present episode seemed just like several previous attacks. The temperature was 99.6 F., pulse rate 110, respirations 20, blood pressure 118/78. There was marked spasm of the upper abdominal muscles and generalized abdominal tenderness. The white blood count was 10,020; the differential count showed 59 per cent neutrophils, 1 per cent myelocytes, 37 per cent small lymphocytes, 1 per cent endothelial cells and 2 per cent eosinophiles. Under liberal doses of morphine and hot packs to the abdomen, the acute episode rapidly subsided and within twenty-four hours following admission the patient was taking fluids freely by mouth with no apparent discomfort and presented no physical signs except slight epigastric tenderness. Three days later, a diagnosis of localized abscess was made but in view of the clinical improvement, drainage was not done

at that time. Two weeks after discovery of the abscess operation was done, the abscess drained and an open perforation of the anterior wall of the stomach was closed with suture. Operative recovery was uneventful but subsequent investigation of the patient revealed that he was still having "stomach trouble."

CASE III. J. K., male, aged sixty-three years, was seen with his physician because of severe abdominal pain of two hours duration; there had been no vomiting. The past history disclosed no complaint of indigestion but there had been mild attacks of dyspnea. The temperature was 97.8 F., pulse rate 60 and respirations 30. The heart was slightly enlarged to the right and the apical impulse diffuse; no rub was heard; there was an occasional premature contraction. The abdomen moved freely with respirations; it was not distended or retracted; there was some tenderness in the epigastrium accompanied by muscle spasm. The white blood count was 8220 with 73 per cent segmented forms, 18 per cent stab cells, 1 per cent juvenile cells, 1 per cent endothelial cells and 6 per cent small lymphocytes. The condition was considered to be a coronary one and medical treatment advised. On the day following, the patient was much improved; the temperature reached 100. F., with a pulse rate of 90 and respirations of 20; he was taking fluids by mouth freely. The abdomen was apparently negative. One week later, a gastrointestinal study showed definite evidence of an active duodenal ulcer. Subsequent cardiac examination including electrocardiography was essentially negative.

CASE IV. F. C., male, aged forty-five years, entered the hospital complaining of severe abdominal pain and vomiting of two hours duration. He had suffered with indigestion for years and there had been frequent attacks of vomiting. The temperature upon admission was 98.4 F., pulse rate 110 and respirations 20. The pain was apparently of the colicky type and between seizures the patient moved about freely in bed. The entire abdomen was spastic with marked tenderness in the upper left quadrant. The white blood count was 13,900 of which 54 per cent were segmented forms, 2 per cent stab cells, 3 per cent juvenile forms, 1 per cent myelocytes, 1 per cent eosinophiles and 5 per cent small lymphocytes. The patient was given morphine freely, nothing by mouth and fluid was supplied by the intravenous route.

At the end of twenty-four hours, the patient stated that he had no pain; however there was some rigidity in the upper left quadrant of the abdomen, and the temperature climbed to 101 F. After three days in the hospital all evidence of the acute process subsided, the examination was negative and the temperature normal. One week later a gastrointestinal study was done which showed an irregular pylorus and a fair sized extragastric area which contained gas and filled with barium. Surgery was advised but refused and later the patient was discharged with no subjective signs.

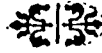
#### CONCLUSIONS

1. Subacute perforations of peptic ulcers are not rare.
2. The subject of subacute perforations is discussed and the literature reviewed.

3. Four personal cases of subacute perforation are cited.

#### REFERENCES

1. SINGER, HARRY A. and VAUGHAN, ROGER T. The "formes frustes" type of perforated peptic ulcer. *Surg., Gynec. and Obst.*, 1: 10, 1930.
2. EISKAMP, E. H. and BLAISDELL, JR., F. E. Perforated gastric ulcer. *California and West. Med.*, 38: 267, 1933.
3. HABEIN, H. C. Subacute perforating duodenal ulcer with unusual symptoms; report of case. *Proc. of Staff Meetings Mayo Clinic*, 10: 33, 1935.
4. SINGER, HARRY A. and VAUGHAN, ROGER T. Treatment of forme fruste type of perforated peptic ulcer. *Surg., Gynec. and Obst.*, 54: 945, 1932.
5. ELIASON, E. L. and EBELING, WALTER W. Catastrophies of peptic ulcer. *Am. Jour. Surg.*, 24: 63, 1934.
6. SHELLEY, HAROLD J. Perforated peptic ulcer. *Am. Jour. Surg.*, 15: 277, 1932.
7. GILMOUR, JOHN and SAINT, JAMES H. Acute perforated peptic ulcer. *Brit. Jour. Surg.*, 20: 78, 1932.





# INFRAMURAL GASTROSTOMY

Visiting Surgeon, Greenpoint Hospital; Consulting Surgeon, Bushwick Hospital; Director, International Medical Center

A. L. SORESI, M.D.

NEW YORK

A PROCEDURE for gastrostomy should be technically simple and provide a permanent means of feeding. Perhaps the most unsatisfactory feature of gastrostomy is leakage of the acid stomach contents.

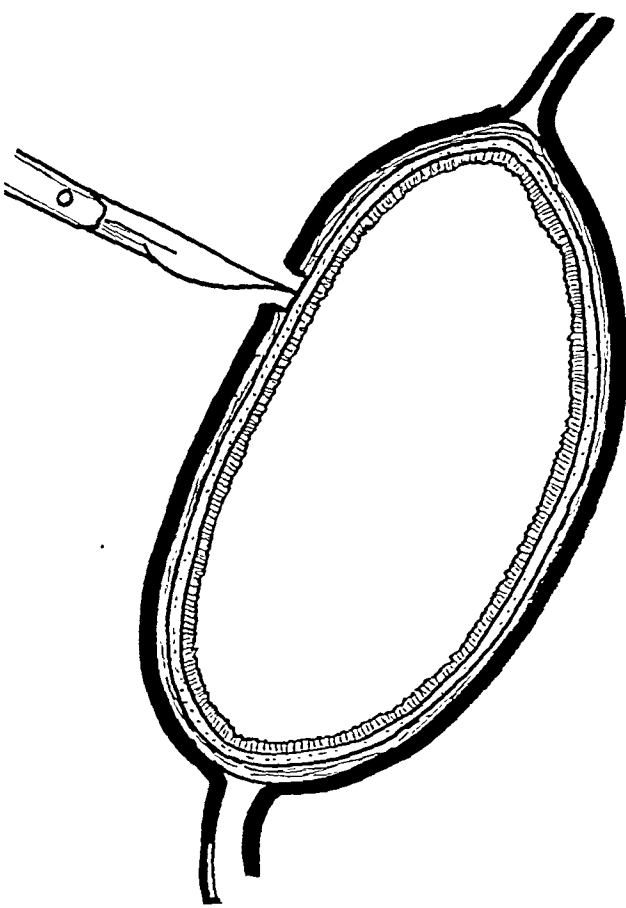


FIG. 1. Incision of serosa and muscularis.

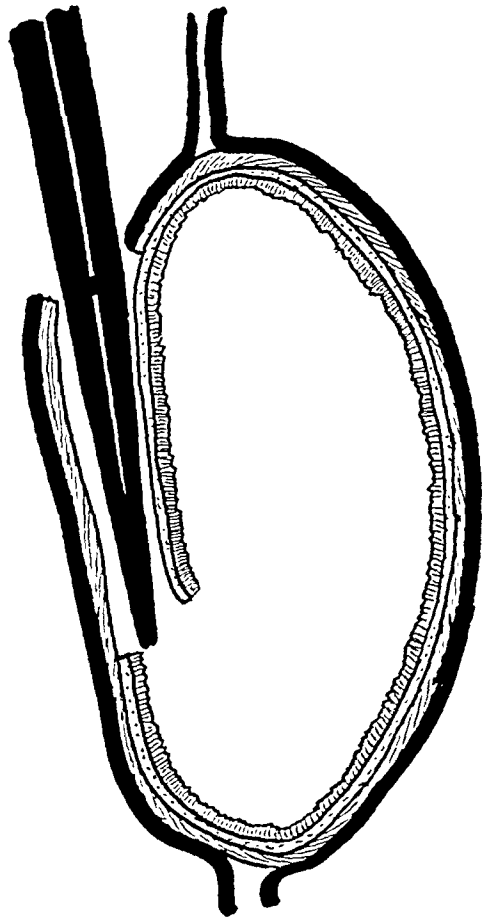


FIG. 2. Scissors creating a tunnel between muscularis and mucosa and making small hole in mucosa.

ing the patient directly through the stomach, because many of these patients constitute the poorest risks.

Permanent good physiological function is essential because a gastrostomy that functions well for a short time only may become such a curse as to render the patient utterly despondent and disgusted.

It might seem useless to present a new procedure for gastrostomy when there are so many excellent ones in use, but I present the inframural technique, hoping that it might be of real service.

The fundamental idea of the inframural gastrostomy is the burrowing of a long

narrow, perpendicular passageway for the catheter between the muscularis and the mucosa of the stomach. This long channel,

tween these two stomach layers is created by pushing the closed scissors downward toward the greater curvature until their



FIG. 3. Relationship of the laparotomy incision, L, and the stab wound incision, C, for the passage of the catheter.

the outer opening of which is close to the upper (small curvature) and the inner to the lower border (greater curvature) of the stomach prevents any spilling of stomach contents.

The procedure is extremely simple. Under local anesthesia the linea alba is incised for about two inches midway between the umbilicus and the xyphoid. The stomach is exposed and raised. As near the border of the small curvature as practical, the serosa and muscularis are incised exposing about one-eighth of an inch of mucosa (Fig. 1). A blunt pair of scissors is then forced between the exposed mucosa and the muscularis and a narrow tunnel be-

points reach the spot in which the surgeon intends to make the inner opening (Fig. 2). A small hole is then made in the mucosa by pressing the points of the scissors on it and opening and closing them slightly, while they press on the mucosa itself. The scissors are withdrawn and a catheter of appropriate size is introduced in the tunnel thus created, until it is felt emerging within the stomach.

A stab incision the size of the catheter is made through the abdominal wall at about 2 cm. to the left of the laparotomy incision (Fig. 3), through which the catheter is carried out of the peritoneal cavity.

Two sutures of No. 2 chromic catgut are then placed on the stomach at the site of the upper incision (Fig. 4). These two

peritoneal coat of the stomach around the stomach incision is thus made adherent to the parietal peritoneum while the passage-

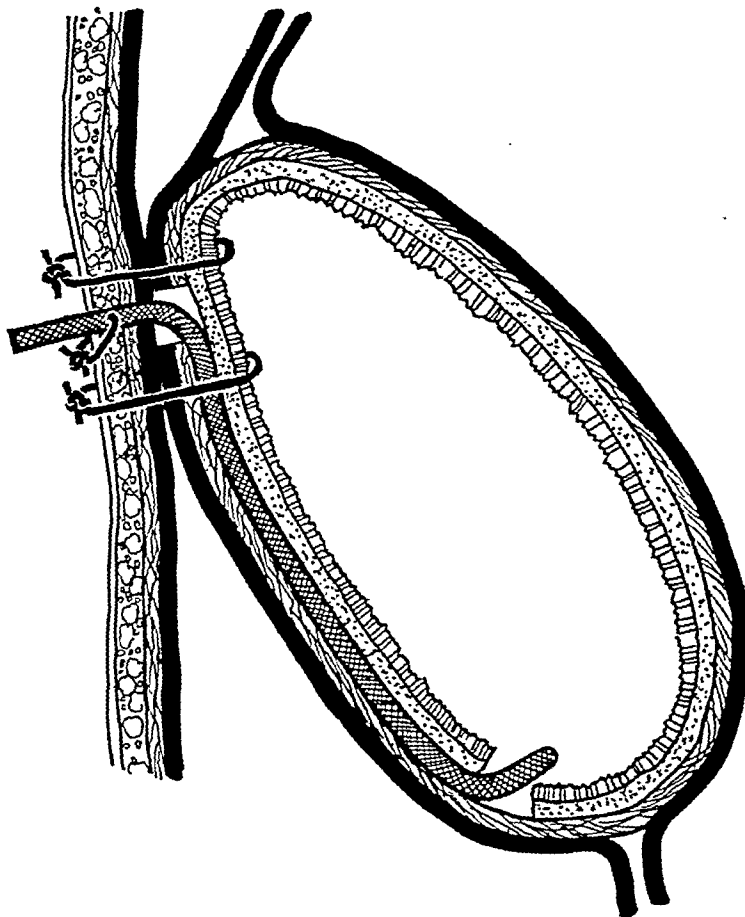


FIG. 4. Catheter passed into stomach through the tunnel between the muscularis and the mucosa. Stitches securing a small portion of the stomach to the parietal peritoneum and catheter are shown in position.

sutures are intended to secure the catheter in the stomach and cause adhesions between the parietal peritoneum and the stomach serosa at the points where the catheter emerges through the wall of the stomach and is carried out through the abdominal wall (Fig. 4). The upper suture is placed about 0.5 cm. above the stomach incision and the lower suture about 0.5 cm. below the same incision.

Both sutures go through the whole thickness of the stomach, the needle entering and emerging a few millimeters beyond the incised stomach serosa. Both ends of each suture are separately brought out through the abdominal wall and tied. The

way for the catheter is excluded from the abdominal cavity with very little area of the stomach itself disturbed. Although the catheter is secured in position by the lower suture (Figs. 3 and 4) it is advisable to add a stitch between the catheter and the skin. The middle incision is then closed in the usual manner.

The patient may be fed immediately.

A small separate stab wound for the passage of the catheter is advised because the laparotomy incision is thereby allowed to heal undisturbed by primary union.

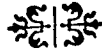
The advantages of the inframural gastrostomy are:

Simplicity and rapidity of performance under local anesthesia; no shock; possibility of feeding the patient immediately; minimal deformity of the stomach; minimum of adhesions; formation of a leakage proof stoma.

#### CONCLUSIONS

A method of producing a long narrow passageway for the feeding catheter

through the stomach wall is described. This passageway besides being long has two openings which are situated perpendicularly at the two extremes of the stomach itself. This arrangement prevents leakage of the stomach contents because fluids cannot travel against gravity and the physiological function of the stomach is left practically undisturbed.



It may be emphasized that neurosurgical experience has thoroughly justified the anatomical concept of the pathways taken by the stimuli which result in cardiac pain . . . Attacks of angina pectoris have invariably stopped after thoracic ganglionectomy or section of the upper thoracic posterior spinal roots, but experience has demonstrated that these operations are dangerous and usually unnecessary. Alcohol injection is safe and, in the hands of an expert, highly successful. It cannot be expected, however, that the occasional operator can inject the upper thoracic ganglia and their rami with uniform success.

Diseases of the Coronary Arteries and Cardiac Pain Edited by

Robert L. Levy, M.D.

# USE OF PITRESSIN FOR CONTROL AND RELIEF OF DISTENTION\*

W. D. FRAZIER, M.D.

Fellow in Surgical Research and Instructor in Surgery, School of Medicine, University of Pennsylvania

PHILADELPHIA

THE use of pituitary preparations for the prevention, control, or relief of postoperative abdominal distention was first mentioned nearly thirty years ago. Since that time a good many reports on the use of pituitary extracts have appeared in the literature, a large number of them lauding the satisfactory results which have been obtained.

It is the twofold purpose of this paper first, to analyze the available experimental and clinical data, and second, to report the results in a series of patients treated with a potent pituitary preparation.

In 1909 Dale<sup>1</sup> first reported that the action of posterior pituitary lobe extracts was one of direct stimulation of the involuntary musculature throughout the body without relation to innervation. In the same year Blair Bell<sup>2</sup> observed the action of an intramuscularly injected pituitary extract on the intestinal tract of pithed rabbits and noted violent peristalsis followed by the expulsion of feces. Accordingly he used it in several cases of postoperative abdominal distention. His report is the first describing its use clinically for the relief of this condition and he stated that the results were generally good in that the extract induced the expulsion of flatus and feces.

Since that time there has been a great deal of experimental and clinical investigation in an effort to determine, (1) the true action of various pituitary extracts on the intestinal musculature, and (2) their value clinically. Unfortunately for the clinician, the laboratory has supplied him with a mass of contradictory evidence. This is

shown by a review of the literature on this subject.

The experimental data can be roughly divided into two main groups, the one attempting to show that the injection of pituitary extract produces either an increase in tone or increased peristalsis, the other indicating that relaxation is the usual effect produced.

To the first group belong the experiments of Franchini<sup>3</sup> who noted severe intestinal contractions with diarrhea in dogs following the injection of extracts of the whole pituitary gland, prepared in his own laboratory. He occasionally found an intense enteritis with submucosal hemorrhages after the injections, usually after large doses had been used, or when the extract had been administered intravenously. Young,<sup>4</sup> using isolated strips of ileum from cats substantiated the contractile properties of the extract, although he remarked on the variability in the degree of this action. Dixon<sup>5</sup> reported a uniform increase in the tone of isolated loops of cat intestine, including portions of both small and large bowel, after the injection of whole gland extract. Using strips from the muscularis of the stomach of cats, dogs and rabbits, McSwiney and Brown<sup>6</sup> likewise observed a constant increase in tone when posterior lobe extract was added to the bath in which the strips were immersed. Boenheim's<sup>7</sup> experiments with posterior lobe extract resulted in strong peristaltic contractions in both the small and large bowel. Gorke and Deloch<sup>8</sup> were the first to study these reactions roentgenologically. After giving their sub-

\* From the Surgical Clinic of the Hospital of the University of Pennsylvania and the Harrison Department of Surgical Research.

jects a barium meal, 1 c.c. of posterior lobe extract was injected subcutaneously and the gastrointestinal tract observed with the fluoroscope. The stomach showed violent contractions, but emptied slowly due to pylorospasm. In the remainder of the intestinal tract they observed an increase in tone and stronger peristalsis.

In the middle ground of the controversy of stimulation versus relaxation stands the work of MacDonald<sup>9</sup> whose experimental results led him to state that although the general effect of posterior pituitary extract was one of stimulation if large enough doses were given, the degree of activity produced was by no means uniform. Shamoff<sup>10</sup> was led to somewhat the same conclusions by his experiments in which he employed several standard commercial preparations of all three parts of the pituitary gland. He was the first to report that the extracts of the anterior lobe and pars intermedia were totally inactive on the smooth muscle of the intestine while that of the posterior lobe produced a wide range of effects on isolated intestinal strips, varying from marked stimulation to definite relaxation. These same preparations, however, showed a uniformity of diuretic and hemodynamic action.

The chief protagonists of the relaxation concept are Voegtlin and Dyer<sup>11</sup> who noted nothing but relaxation in strips of rat jejunum immersed in solutions of posterior lobe extract of varying concentrations. Similar results were reported by Hoskins<sup>12</sup> who suggested that the reason for his failure to obtain the stimulation found by others may have been some substance used in the preparation of his extracts. It remained for Roth<sup>13</sup> to prove this point by showing that extracts prepared with chlorbutanal or chloretone produced intestinal relaxation while his own preparations, free from these substances, caused an increase in tone. Evidence has also been brought forward to show that the diet<sup>14</sup> and the emotional state<sup>15</sup> of animals from whom the gland is removed for extraction has a

definite influence on the type of reaction which the extract produces.

Geiling<sup>16</sup> in his review published in 1926 summed up the then existing thought on the action of posterior lobe extract by stating that though some recent work showed a tendency toward relaxation the main evidence was in favor of stimulation of the gastrointestinal musculature. He considered the method of preparation as an important factor in determining the type of effect which the extract will produce, and besides the factors already mentioned suggested that excessive acidity might result in a "relaxing" instead of a "stimulating" extract. Kauffman,<sup>17</sup> however, shortly thereafter, demonstrated that alkalization produced no change in the stimulating action of his preparations, but was able to show, that by varying the pH during his extractions, the fraction which caused intestinal contraction was different from that which raised the blood pressure and stimulated the uterus. It was not long after this that Kamm<sup>18</sup> and his co-workers isolated two active principles from the posterior lobe of the pituitary gland, a pressor and an oxytocic fraction. They made no attempt to determine the various actions of these principles on the intestinal musculature. Elmer, Ptaszek and Scheps<sup>19</sup> demonstrated that the two fractions had separate actions on the intestinal musculature which were antagonistic, the pressor fraction stimulating, the oxytocic relaxing. Their work further showed that when injected together, the effect of one was neutralized by the effect of the other. This was further illustrated by the fact that the vasopressor fraction produced much greater stimulation than pituitrin, which, of course, contains some of both principles.<sup>20</sup> These findings have recently been confirmed by Melville.<sup>21</sup> This, therefore, serves in part to explain the variability in the activity of the older extracts of the posterior lobe, which contained varying amounts of both fractions—pressor and oxytocic.

Most of the related experimental work done since that time tends to confirm the earlier concept, namely, that the pressor fraction of posterior lobe extract has a very definite stimulating action on the normal intestinal musculature. Ample evidence of this is found in the work of Carlson,<sup>22</sup> Robson,<sup>23</sup> Gruber and Robinson,<sup>24</sup> Krishnan<sup>25</sup> and Elmer, Ptaszek, and Scheps.<sup>26</sup>

The only results which do not fall in line with this concept were some obtained in abnormal states of the intestinal tract. MacIntosh and Owings<sup>27</sup> showed that the vasopressor fraction caused a fall in tonus and a decrease in peristaltic activity in the small intestine of dogs where complete mechanical obstruction had been obtained by transection of the lower ileum. They made their determinations by measuring pressure changes in a balloon placed within the bowel just above the site of obstruction. Using the same balloon technique in isolated closed loops of both small and large bowel, Quigley and Barnes<sup>28</sup> also noted a constant decrease in tone and motility after use of the pressor fraction. These results are understandable and the distinction between the effect of the pressor fraction on normal and abnormal bowel is a valid one. Melville and Stehle<sup>29</sup> isolated special pressor and oxytocic fractions for their own use and compared their action on isolated loops and on the normal gastrointestinal tract observed by fluoroscopic examination after the ingestion of barium. With the pressor substance they observed uniformly an increase in intestinal motility with contraction often followed by defecation. The isolated loops, however, showed no clear cut effect. In all instances the action of the pressor substance was identical with that of commercially prepared pitressin; their oxytocic fraction and commercial pitocin gave constant evidence of relaxation.

The preponderance of evidence, therefore, points to the fact that the pressor fraction of the posterior lobe of the pituitary gland exerts a stimulating effect

on gastric and intestinal musculature under normal conditions. That this effect is variable in the intensity of its action is not more difficult to understand than the variability of other hormone actions. No definite statement can be made as to the degree of activity of the pressor fraction on the different parts of the gastrointestinal tract.

While the investigative work was being carried on in the laboratory, clinicians were experimenting with the action of pituitary preparations on abdominal distention in the patient. The first report of its use, following Blair Bell's<sup>2</sup> original article, was in a symposium on the treatment of generalized peritonitis. Renton<sup>30</sup> reported that he had obtained satisfactory results with intramuscular injections of pituitary extract both before and after drainage operations. The extract not only increased peristalsis but also brought his patients out of shock. The several other articles and the subsequent discussions failed to disclose any further information on the subject, showing that the use of this substance was still in the experimental stage. The following year (1911) Bidwell<sup>31</sup> discussed his results after the routine postoperative use of pituitary extract in 21 unselected cases on whom laparotomy was performed, all involving excessive trauma, or infection. One cubic centimeter of the extract was injected every six hours for twenty-four to thirty-six hours. In all but one patient there resulted the early passage of flatus, absence of distention or of marked abdominal discomfort. These patients all had remarkably slow pulse rates and no untoward reactions of any kind were observed. It is interesting to note that one woman four and a half months pregnant was carried through such a regime without mishap.

One other article<sup>32</sup> appeared at this time advocating the use of pituitrin in peritonitis but emphasis was placed on its hemodynamic action.

During the next three years a series of papers were published from different coun-

tries reporting favorably the use of various pituitary preparations in postoperative abdominal distention with, and without, infection of the peritoneum.<sup>33-38</sup> In all, 59 cases were reported and emphasis was placed on the consistent ability of pituitary preparations to produce peristalsis and the expulsion of flatus and feces, where all other measures failed. In the majority of patients the preparation was given hypodermically and no unpleasant effects were recorded. One review,<sup>34</sup> however, mentions the dangers of administering it intravenously and describes the intense pallor, rapid irregular pulse, shallow respiration, semistupor and intense frontal headache which occasionally follow this method of administration.

There follows a period of about ten years during which mention was rarely made of the use of any pituitary extract in abdominal surgery.

In 1924, Blake<sup>39</sup> reported favorably on the use of pituitrin in peritonitis and his article was followed shortly by Mayer's<sup>40</sup> description of the intravenous use of a similar preparation in 52 cases of peritonitis complicated by severe ileus. Four to six cubic centimeters were given in 500 to 1000 c.c. of physiological saline solution. Twenty per cent of all the cases survived, this number comprising about 30 per cent of the cases in which the ileus was relieved by the drug. All patients who were not relieved by the extract succumbed. A comparable percentage of recoveries from peritonitis (22 per cent) in a series of 81 cases treated in a similar manner was reported by Vogt.<sup>41</sup>

Potter and Mueller<sup>42</sup> then published results on the prophylactic treatment of postoperative abdominal distention with pituitary preparations. One hundred patients received 1 c.c. of surgical pituitrin every four hours for six doses. Distention rarely developed and then only in those patients who were distended preoperatively or after the pituitrin had been discontinued. In 1928, after Kamm et al. had isolated the pressor fraction another series of 100 pa-

tients were treated with 8 to 12 postoperative injections of 1 c.c. of the pressor fraction at four hour intervals. Of this group only 2 developed any distention and no untoward effects were observed.

In view of their results and three other subsequent favorable reports on the use of pitressin<sup>26,43,53</sup> from German and British clinics it is strange that a review of the American literature on the treatment of distention with or without peritonitis during the past five years reveals an almost unanimous feeling of condemnation of the use of pitressin or similar substances.<sup>44-51</sup> The chief reasons given against its use are (1) that its temporary stimulating effect is followed shortly by more complete relaxation, (2) that it only affects the large bowel, which is rarely involved in postoperative ileus, and (3) that it produces stimulation of the bowel, when rest is indicated. Another author on the subject feels that "the momentary (beneficial) effect is a negligible violation of the principle of rest" in peritonitis.<sup>43</sup> There is, of course, ample experimental evidence to show that the small bowel is as actively affected by the pressor fraction as is the colon.

More recently Rundle<sup>54</sup> has reported on the intravenous use of pitressin. He used 0.5 to 1 c.c. injected very slowly; 6 cases were so treated, 4 clean and 2 with peritonitis. None showed any untoward reaction and the results in all were prompt and dramatic with the passage of feces and flatus, in some cases even before the injection was completed.

In summing up the status of the clinical use of pituitary preparations several rather interesting points are prominent. In the first place after a period of nearly thirty years during which they have been used in many clinics the world over, there is no unanimity of opinion as to their value. Furthermore, no explanation has been offered for the marked variations in their effectiveness. This, of course, includes the period prior and subsequent to the isolation of the vasopressor fraction of the



posterior lobe. Before its isolation extracts from the whole lobe were used and there is adequate explanation for the lack of uniformity of effect of these preparations, in the proved antagonistic action of the two fractions. Since that time, however, only the pressor fraction has been employed.

The second outstanding fact is that, while British and German authors continue to report satisfactory results, American surgeons have not only ceased to use the substance except in occasional cases, but also have unanimously condemned its use in patients where the distention is associated with peritoneal infection. The reason for this state of affairs is not obvious unless possibly it implies that there is some essential difference between the commercial preparations here and abroad.

A final interesting fact is that, although almost everyone who has written on this subject has mentioned the possible dangerous reactions which may occur after the injection of pitressin, no one has reported a single case which was seriously or critically affected by such a reaction, even after intravenous administration,<sup>54</sup> and not one death has ever occurred. Since the incidence of these reactions is so low and their effect, as a rule, so mild and transient, it does not seem probable that they can have played any part in influencing any one against the use of pitressin.

In an effort to determine at first hand the value of pitressin in postoperative abdominal distention and its associated symptoms, the substance was administered to a series of 94 patients on the surgical service of Dr. I. S. Ravdin at the Hospital of the University of Pennsylvania. The results were carefully observed and recorded on a specially prepared sheet on the patient's chart. The amount given subcutaneously varied from 0.5 to 1 c.c. every four hours given for as long as ninety-six hours. The series includes a group to whom it was given routinely after operation without waiting for symptoms to develop, another group who received pit-

ressin to relieve distention and gas pains, a third small group to whom it was given to control severe and obstinate distention due to ileus from some other cause than operative trauma or infection and finally a group with widespread peritoneal infection.

The various types of operation which these patients underwent are listed below. The results can best be shown in Tables I, II, III, IV, V and VI.

TABLE I

|  |    |
|--|----|
| No operation.....                      | 4  |
| Cholecystectomy.....                   | 8  |
| Cholecystostomy.....                   | 3  |
| Appendectomy.....                      | 30 |
| Appendectomy—drained.....              | 12 |
| Herniorrhaphy.....                     | 8  |
| Lysis of adhesions for obstruction.... | 7  |
| Pelvic operations.....                 | 3  |
| Ileostomy and cecostomy.....           | 7  |
| Closure of perforated ulcer.....       | 3  |
| Intestinal resections.....             | 2  |
| Splenectomy.....                       | 4  |
| Gastroenteroenterostomy.....           | 3  |
| Total.....                             | 94 |

TABLE II

| Total No. of Cases, 24  |     |             |                          |                         |
|---|-----|-------------|--------------------------|-------------------------|
| Patients given Pitressin by Routine Post-operative Administration | No. | No Symptoms | Patients with Distention | Patients with Gas Pains |
| 0.5 to 1 c.c. every four hours.....                               | 24  | 17          | 4                        | 3                       |

TABLE III

| Patients given Pitressin Post-operatively for Distention |     |          |            |            | Patients Who Passed |       | Marked Increase in |
|--|-----|----------|------------|------------|---------------------|-------|--------------------|
| Degree of Distention                                     | No. | Improved | Unimproved | Made Worse | Gas                 | Feces | Peristalsis        |
| Minor.....   | 9   | 6        | 3          | 0          | 5                   | 1     | 4                  |
| Moderate.....  | 38  | 37       | 1          | 0          | 26                  | 10    | 10                 |
| Marked.....  | 19  | 14       | 5          | 0          | 13                  | 6     | 8                  |

In the entire series only 3 patients suffered reactions following the injection of pitressin. These were characterized by in-

tense pallor, headache, shallow respirations and a rapid thready pulse. All were transient, lasting from ten minutes to one hour, and the patients recovered spontaneously without the administration of any stimulants.

TABLE IV

| Patients given Pitressin Postoperatively for Gas Pains |     |               |                 |               |
|--|-----|---------------|-----------------|---------------|
| Severity of Gas Pains                                  | No. | Im-<br>proved | Unim-<br>proved | Made<br>Worse |
| Minor.....   | 7   | 7             | 0               | 0             |
| Moderate.....  | 25  | 21            | 4               | 0             |
| Marked.....  | 15  | 14            | 1               | 0             |

TABLE V

| Cases with Distention Unoperated | No. | Improved | Unimproved |
|----------------------------------|-----|----------|------------|
|                                  | 4   | 3        | 1          |

TABLE VI

| Cases with Widespread Peritonitis | No. | Distention<br>Improved | Distention<br>Unimproved |
|-----------------------------------|-----|------------------------|--------------------------|
| Recovered.....                    | 10  | 10                     | 0                        |
| Died.....                         | 5   | 3                      | 2                        |

One other fact must be recorded. Blood pressure readings were determined on the majority of these patients just before and shortly after one or more injections. We were able to find no marked rise or fall in either systolic or diastolic pressure following the injection of pitressin in any case.

In our experience, pitressin has proved a valuable agent in the prevention and relief of abdominal distention due to adynamic ileus resulting from operative trauma, and peritoneal infection. Reactions are few, mild and transient and associated with no danger to the patient. Blood pressure is apparently not affected. We, therefore, do not hesitate to recommend its use in combatting this distressing postoperative symptom.

SUMMARY

1. The experimental and clinical literature on the effect of posterior pituitary

lobe preparations on the gastrointestinal tract is reviewed and analyzed.

2. A series of 94 cases treated with pitressin is reported and the results tabulated. Relief from symptoms was obtained in the majority of cases.

REFERENCES

1. DALE, H. H. *Biocbem. Jour.*, 4: 427, 1909.

2. BELL, BLAIR. The pituitary body. *Brit. Med. Jour.*, 2: 1609, 1909.

3. FRANCHINI, G. Die Funktion der Hypophyse und die Wirkungen der Injektion ihrer Extraktes bei Tieren. *Berl. klin. Wchnschr.*, 47: 670, 719, 1910.

4. YOUNG. On the movements of isolated small intestines and action of various drugs and extracts upon them. *Quart. Jour. Exper. Physiol.*, 8: 347, 1915.

5. DIXON, W. E. Pituitary secretion. *Jour. Physiol.*, 57: 136, 1922.

6. McSWINEY, B. A. and BROWN, G. L. Reversal of action of adrenalin. *Am. Jour. Physiol.*, 62: 52, 1926.

7. BOENHEIM, FELIX. Uber die Einfluss der Inkrete auf die Motilität der Verdauungstraktus. *Ztschr. f. d. ges. exp. Med.*, 32: 179, 1923.

8. GORKE, H. and DELOCH, E. Uber den Einfluss von hypophysen Extrakten auf den Magendarmtraktus und das Blut des Menschen. *Arch. f. Verdauungskr.*, 29: 149, 1922.

9. MACDONALD, A. J. Action of pituitary extracts on intestinal muscle. *Quart. Jour. Exper. Physiol.*, 15: 191, 1925.

10. SHAMOFF, V. N. Concerning the action of various pituitary extracts upon isolated intestinal loops. *Amer. Jour. Physiol.*, 39: 268, 1916.

11. VOEGTLIN, C. and DYER, H. A. Natural resistance of albino rats and mice to histamine, pituitrin and certain other poisons. *Jour. Pharmacol. and Exper. Therap.*, 24: 101, 1925.

12. HOSKINS, R. G. Action of pituitary extracts. *J. A. M. A.*, 66: 733, 1916.

13. ROTH, G. B. Pituitary standardization. U. S. Public Health Service Hygiene Lab. Bull. No. 109, 1917.

14. UNO, T. Effect of excitement on ductless glands of rat. *Am. Jour. Physiol.*, 61: 203, 1922.

15. DEGENER, L. M. Studies on effect of diet on action of hypophysis and thyroid extracts on isolated small intestine. *Am. Jour. Physiol.*, 60: 107, 1922.

16. GEILING, E. M. K. The pituitary body. *Physiol. Rev.*, 6: 62, 1926.

17. KAUFMAN, M. Uber die Darmwirkung der Auszuge des Hypophysenhinterlappens. *Arch. f. exper. Path. u. Pharm.*, 120: 322, 1927.

18. KAMM, OLIVER, ALDRICH, T. B., GROTE, T. W., ROWE, L. W. and BUGBEE, E. P. Active principles of posterior lobe of pituitary gland. *Jour. Am. Chem. Soc.*, 1: 573, 1928.

19. ELMER, A. W., PTASZEK, L. and SCHEPS, M. Experimentelle Untersuchungen der Wirkung des Vasopressins und Oxytocins auf die peristaltische Darmbewegungen und die Behandlung des Ileus

- Paralyticus mit Vasopressins. *Gaz. Lek.*, 9: 341, 1930.
20. ELMER, A. H. and PTASZEK, L. Action comparée de la vasopressine et de la pituitrine sur le peristaltisme intestinale. *Compt.-rend. Soc. de biol.*, 104: 540, 1930.
  21. MELVILLE, K. I. Pressor and oxytocic fractions of post pituitary extract. *J. A. M. A.*, 106: 102, 1936.
  22. CARLSON, H. A. Effect of post pituitary lobe extracts on the intestines of man and animals. *Proc. Soc. Exper. Biol. and Med.*, 27: 777, 1930.
  23. ROBSON, J. M. Reactions of isolated muscle strips of stomach to the oxytocic and pressor fractions of an extract of the posterior pituitary lobe. *Quart. Jour. Exper. Physiol.*, 21: 265, 1931.
  24. GRUBER, C. M. and ROBINSON, P. I. Influence of pituitary extract, vasopressin and oxytocin on intact intestine in unanesthetized dogs. *Jour. Pharmacol. and Exper. Therap.*, 36: 203, 1929.
  25. KRISHNAN, B. T. Influence of adrenalin, pituitary extract and insulin on movements of intestines. *Indian Jour. Med. Res.*, 22: 161, 1934.
  26. ELMER, A. W., PTASZEK, L. and SCHEPS, M. Die Wirkung des Vassopressine and Oxytocine auf der Darmperistaltik und die Behandlung der Darmlähmung mit Vasso pressine. *Klin-Wchenschr.*, 9: 1765, 1930.
  27. MCINTOSH, C. A., and OWINGS, S. C. Effect of solutions of pituitrin and various drugs on the movements of the small intestine during simple mechanical obstruction. *Arch. Surg.*, 17: 996, 1928.
  28. QUIGLEY, J. P. and BARNES, B. O. Action of insulin on motility of gastrointestinal tract. vi. Antagonistic action of post pituitary lobe preparations. *Am. Jour. Physiol.*, 95: 7, 1930.
  29. MELVILLE, K. E. and STEHLE, R. L. The Actions of pituitary preparations (post lobe) upon the intestines of the dog. *Journ. Pharmacol. and Exper. Therap.*, 50: 165, 1934.
  30. RENTON. Discussion of Rutherford Morison's "Treatment of General Septic Peritonitis." *Brit. Med. Jour.*, 2: 1066, 1911.
  31. BIDWELL, L. A. Investigation into the effect of pituitary extract on the bowels after abdominal operations. *Clin. Jour.*, 38: 351, 1911.
  32. KALTZ, R. Pituitrintherapis dei Peritonitis. *München. med. Wchenschr.*, 59: 2047, 1912.
  33. BISHOP. After treatment of abdominal sections. *Practitioner*, 89: 11, 1912.
  34. HOUSSAY and BERUTI. Sur l'emploi de la medication hypophysaire comme agent enterocinetique. *Presse Méd.*, 21: 613, 1913.
  35. HARVEY, T. W. Pituitary preparations in post-operative conditions. *Med. Rec.*, 85: 525, 1914.
  36. STANLEY. Pituitrin in intestinal paresis following abdominal operations. *Surg. Gynec. and Obst.*, 18: 766, 1914.
  37. PORRITT, N. Pituitrin in postoperative intestinal stasis. *Brit. Med. Jour.*, 1: 1118, 1914.
  38. DUFFY. Pituitary extract in postoperative intestinal stasis. *New York Med. Jour.*, 101: 72, 1915.
  39. BLAKE, J. A. Treatment of suppurative peritonitis. *Ann. Surg.*, 79: 710, 1924.
  40. MAYER, A. Zur Behandlung Postoperativer Darmlähmungen. *München. med. Wchenschr.*, 71: 931, 1924.
  41. VOGT, E. Die Intravenöse Hypophysin—Kochsalzinfusion zur Behandlung der postoperativen Darmlähmung. *München. med. Wchenschr.*, 73: 1509, 1926.
  42. POTTER, R. C. and MUELLER, R. S. Posterior pituitary extract in the prevention of postoperative intestinal distention. *Ann. Surg.*, 96: 364, 1932.
  43. TYRRELL, GRAY, T. Ileus: active and paralytic. *Brit. Med. Jour.*, 1: 1161, 1930.
  44. GUTHRIE, DONALD. Prevention and treatment of postoperative ileus. *Tr. South. Surg. and Gynec. Assoc.*, 44: 143, 1931.
  45. RANSOHOFF, J. L. and HEIMANN, J. D. Recognition and treatment of paralytic ileus. *West. Jour. Surg.*, 41: 331, 1933.
  46. DELPRAT, G. D. and WEEKS, A. Postoperative intestinal obstruction. *Am. Jour. Surg.*, 8: 189, 1930.
  47. McIVER, M. A. Acute intestinal obstruction. *Am. Jour. Surg.*, 20: 833, 1933.
  48. McIVER, M. A., BENEDICT, E. B. and CLINE, J. W. Postoperative gaseous distention of intestine. *Arch. Surg.*, 13: 588, 1926.
  49. OCHSNER, A. and GAGE, I. M. Adynamic ileus. *Am. Jour. Surg.*, 20: 378, 1933.
  50. OCHSNER, A. Beitrage zum paralytischen Ileus. *Schweiz. med. Wchenschr.*, 65: 93, 1935.
  51. ROSS, KEITH. Paralytic ileus. *Med. Jour. Australia*, 2: 186, 1934.
  52. MATTHEWS, A. A. Adynamic ileus. *Surg. Clin. N. Amer.*, 14: 1443, 1934.
  53. KIMMERLING, G. Elective action of pituglandol in paralytic and obstructive ileus. *Gaz. Lek.*, 8: 27, 1929.
  54. RUNDLE, F. H. Intravenous pituitrin in postoperative ileus. *Brit. Med. Jour.*, 2: 1208, 1935.
  55. OCHSNER, A., GAGE, I. M. and CUTTING, R. A. Value of drugs in relief of ileus. *Arch. Surg.*, 21: 924, 1930.
  56. GORRY, R. C. Die Wirkung der Hinterlappensubstanzen auf den peristaltisch-tötigen Dünndarm des Meerschweinchens. *Arch. f. exper. Path. u. Pharm.*, 120: 348, 1927.
  57. BOENHEIM, FELIX. Die Bedeutung der Blutdrüsen für den Verdauungstraktus. *Arch. f. Verdauungskr.*, 35: 337, 1925.
  58. KOENIGSBERGER, E. and MANSBACHER, W. Therapeutische Versuche mit Hypophysin bei Magenatonie in Säuglings und Kindesalter. *Ztschr. f. Kinderb.*, 44: 265, 1927.



# MALUNITED FRACTURES OF LOWER END OF HUMERUS\*

A. R. SHANDS, JR., M.D.

Associate Professor of Surgery, in Charge of Orthopedics, Duke University School of Medicine

DURHAM, N. C.

THE patient who has a malunited fracture of the lower end of the humerus seeks the advice of the orthopedic surgeon because of a stiff and unsightly elbow. The deformity and disability usually are due to union of the fragments in faulty alinement. The poor result may have followed a circulatory disorder in the forearm and hand which accompanied the fracture and necessitated a delayed reduction, or it may have been due to inexperience on the part of the attending doctor; however, malunion and functional disability may occur even in the hands of the most skillful fracture surgeon. This paper is presented not as an original contribution but as a review of the commoner methods of management of malunited fractures of the lower end of the humerus and as a short comment upon their most frequent complications.

The elbow is an intricately fashioned joint. After fracture involving the articular surfaces, it is often very difficult to effect accurate reapproximation of the fragments, particularly in the case of comminuted intercondylar fractures. In the restoration of a joint following an old fracture, the primary object of treatment is to obtain improvement of its function; the secondary object is to improve its appearance, but function must never be sacrificed in any way for appearance. The hinge-like motion between the ulna and the lower end of the humerus is of greater usefulness than the rotary motion of the head of the radius upon the capitellum; however, a perfect result in the treatment of fracture about the elbow joint must include restoration of both of these motions.

The circulation about the lower end of the humerus is abundant. When non-union

occurs it is never a result of inadequate blood supply but is due to unsatisfactory approximation of the fragments. Due to the frequency of stripping and tearing of the periosteum in these elbow fractures, excessive callus formation and calcification occur within the surrounding tissues and may lead to partial ankylosis. The amount of osteogenesis following bone injury about the elbow is in direct proportion to the degree of periosteal injury. Fractures with marked displacement are accompanied by the largest amount of new bone formation. The excessive callus may form a serious handicap to a good functional result.

In young children epiphyseal injury is an important lesion. Accurate approximation of the epiphyseal surfaces is often difficult to obtain, even by open operation. With subsequent growth a distortion of the joint often occurs, resulting in serious deformity and disability. In very young children the extent of the epiphyseal injury cannot be visualized accurately in roentgenograms because of the large proportion of cartilage present. In the interpretation of the roentgenogram care must be taken to differentiate between the epiphyseal line and a fracture line. A comparison with the roentgenogram of the normal elbow is helpful. Fortunately, epiphyseal separations are not so common as fractures.

In the reposition of malunited fractures the angle of the lower end of the humerus to the shaft must be considered. The normal elbow in extension has a carrying angle of from 6 to 16 degrees; i.e., the forearm possesses this amount of lateral deviation from the longitudinal axis of the upper arm. The carrying angle is dependent upon the contour of the lower end of the humerus and the upper end of the radius and the

\* Presented before the American Academy of Orthopaedic Surgeons, St. Louis, Mo., January 15, 1936.

ulna. The articular surface of the lower end of the humerus forms anteriorly an angle of 45 degrees with the longitudinal

Five types of malunited fracture of the lower end of the humerus lead frequently to functional disability: (1) supracondylar,

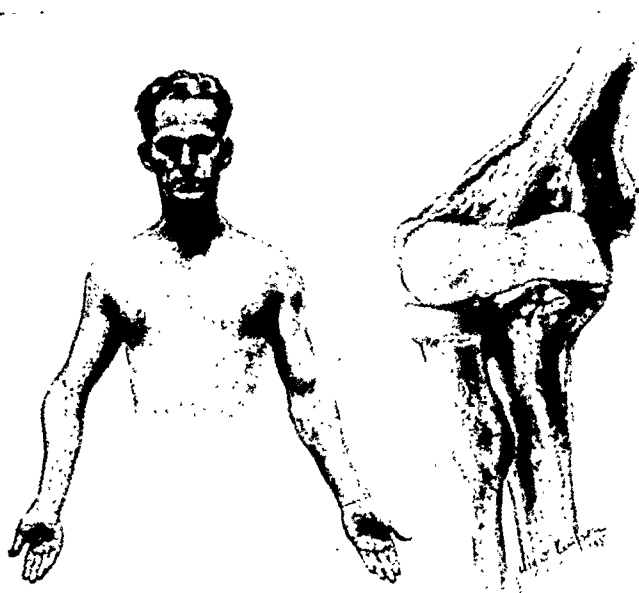


FIG. 1. Old supracondylar fracture showing cubitus varus.

axis of the shaft; this angle also must be considered in the reposition of these fractures. Accurate restoration of the carrying angle, while not essential to complete functional recovery, is necessary if a perfect anatomical result is to be obtained. In the restoration of the carrying angle, injury of the internal lateral ligaments is of importance, since relaxation of these structures tends to result in increased valgus.

Any varus or valgus deformity of the elbow is accompanied by a change in the carrying angle and is spoken of as a gunstock deformity. The most common deformity is a cubitus varus, or loss of the normal carrying angle; it may occur following supracondylar fracture (Fig. 1). A cubitus valgus deformity most often results from fracture and displacement of the external condyle (Fig. 2). In addition to the gunstock deformity a bony projection may occur about one of the condyles and give the elbow an unsightly appearance. The healing of displaced intercondylar fractures is often accompanied by considerable broadening of the lower end of the humerus.

including diacondylar fracture and separation of the lower humeral epiphysis, (2) external condylar, (3) internal condylar, (4) intercondylar or comminuted "T" or "Y" fractures and (5) fractures involving the articular surface of the capitellum or trochlea.

The treatment and prognosis of each of these five types of fracture will be discussed individually, but there are certain general considerations which apply to the entire group. Most authors believe that in operating upon these malunited fractures conservatism is most important. Cotton reports the observation that in a great many cases surgery is followed by increased bone proliferation and further loss of function, especially when an attempt is made to remove bone filling the coronoid or olecranon fossa or deposited about the external condyle.

Campbell has enumerated the following five objects of reconstructive operations upon the lower end of the humerus: (1) reconstruction of a normal contour and alinement of the elbow joint surfaces, with

especial reference to the carrying angle; (2) improvement or complete restoration of motion; although mobility is desirable,

occur following complete reduction. It must be borne in mind, however, that hyperflexion cannot be carried to the point

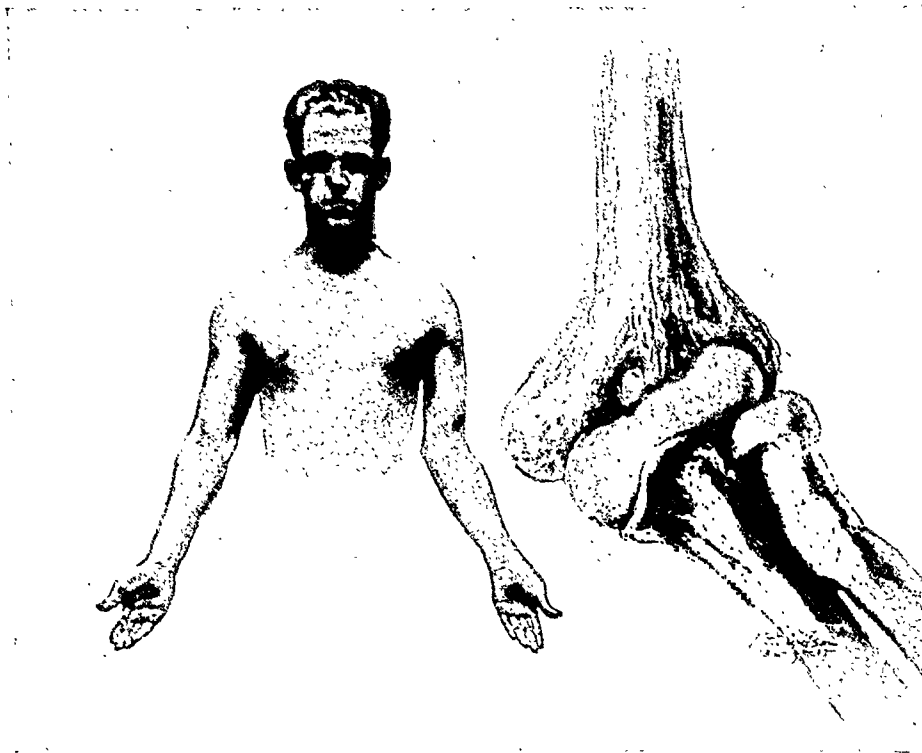


FIG. 2. Old supracondylar fracture showing cubitus valgus.

however, stability or efficient function should not be sacrificed for the mere restoration of motion; (3) preservation of the condyles with their articular surfaces, when possible, and the promotion of union between the detached condyles and the shaft in as nearly the normal relationship as possible; (4) in "T" fractures, union and proper alinement between the condyles themselves and between the condyles and the shaft; and (5) excision of bony blocks or bridges that prevent full motion. When the disability is due to an excess formation of callus, or to a myositis ossificans, no operation should be attempted until ossification has become complete.

Ashhurst in 1910 stated that the secret of a good functional result is an early accurate reduction with fixation in hyperflexion. The position of hyperflexion favors preservation of the normal carrying angle, as the triceps tendon and muscle hold the fragments in position when the elbow is hyperflexed. Ashhurst contended that circulatory disturbances were unlikely to

at which obliteration of the radial pulse takes place.

Eikenbary, among others, has advocated for these elbow fractures less physical therapy and more active motion. He feels that manipulation in an attempt to increase the range of elbow motion is often followed by tragic results.

#### SUPRACONDYLAR FRACTURES

In this group are included not only fractures above the condyles, in which the shaft takes a distinct forward bend, but also those through the condyles, or diacondylar fractures, and the traumatic displacements of the whole lower epiphysis. Separation of the entire lower epiphysis is very uncommon after four years of age. A very rare type of fracture which belongs in this group is that described in 1901 by Professor Posadas of South America; this is a diacondylar fracture with posterior displacement of the radius and ulna. This fracture practically always results in anky-

losis of the elbow, although Ashhurst reported one case in which a good functional result was obtained after a closed reduction.

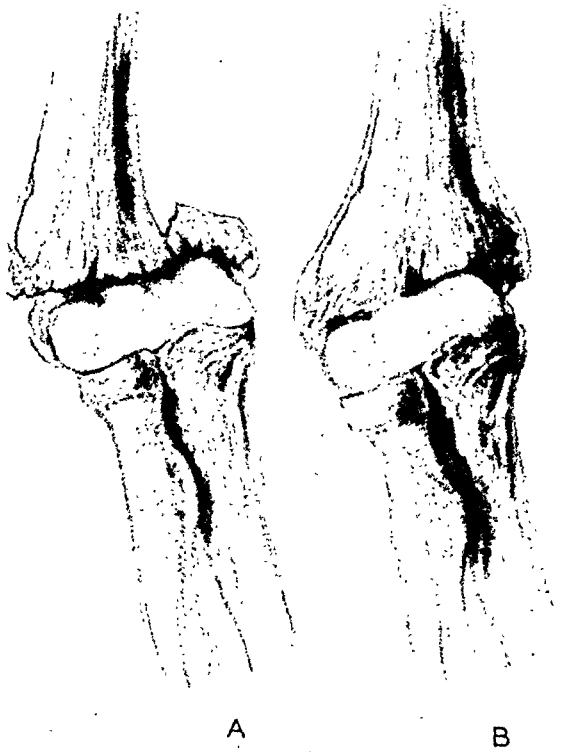


FIG. 3. Supracondylar fracture in a boy, aged eight years (anteroposterior views); A, immediately after fracture; note medial and posterior displacement of lower fragment; B, three years later, showing cubitus varus deformity; function in elbow is normal; this fracture was never reduced. (After Sever and Gallupe.)

Supracondylar fractures are commonest in children whereas the external condylar fractures are more frequent in adults. Gilcreest reports that one-third of the fractures about the elbow joint are of the supracondylar type. He describes four varieties of supracondylar fracture: (1) the extension type is the most frequent; in this the fracture line passes from the anterior surface upward and backward, and the lower end of the upper fragment is displaced into the antecubital space; (2) the flexion type, which is the reverse of the extension type and in which the long upper fragment becomes displaced posteriorly; (3) the adduction type, and (4) the abduction type. Either of the two latter types

may be associated with either of the two former. The flexion and extension supracondylar fractures were first described by Kocher.

In supracondylar fractures in children a good functional elbow with very little evidence of deformity may follow even marked displacement of the fragments (Figs. 3 and 4). This fact emphasizes the need for conservatism in the treatment of supracondylar fractures in childhood. Eliason says, "Do not pass on the result for at least a year. Children obtain good results, but patients past middle life get rather unsatisfactory function."

The most common types of malunion are: (1) a backward displacement of the lower fragment with the lower end of the shaft projecting into the antecubital space; (2) in addition to the backward displacement of the lower fragment there is a lateral or medial displacement and rotation, usually the inner side going posteriorly, resulting in cubitus varus; and (3) a forward displacement of the lower fragment, which also may be displaced medially and rotated.

Forward displacement of the lower fragment occurs in supracondylar fractures of the flexion type.

After solid union has taken place there may be limitation of flexion due to projection of the upper fragment into the antecubital space. It may be advisable to make a lateral incision and chisel off the projecting bone, as first described by Finney. Care must be taken to remove more bone than is absolutely necessary to permit full flexion.

Sinclair recommends that the spur which projects into the elbow joint should be removed by means of a burr attached to an electric saw. This is a very simple and effective method. This operation is not always indicated in children, as is exemplified by the case shown in Figure 5. As epiphyseal growth continues it is evident that the upper fragment grows away from the joint and at the same time the projecting bone is absorbed and becomes progres-

sively less prominent. After operative removal of bony spurs motion should be started early.

alinement (Fig. 6). If there is a bone fragment projecting into the antecubital space, this can be removed at the same time.

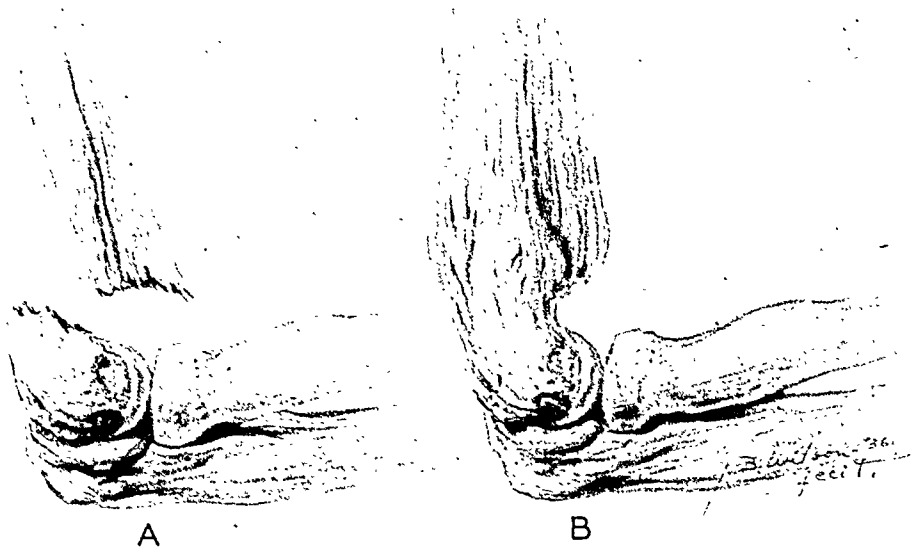


FIG. 4. Supracondylar fracture in a boy aged eight years (lateral views); A, immediately after fracture showing displacement of fragments; B, three years later; this fracture was never reduced. Function normal. (After Serer and Gallupe.)

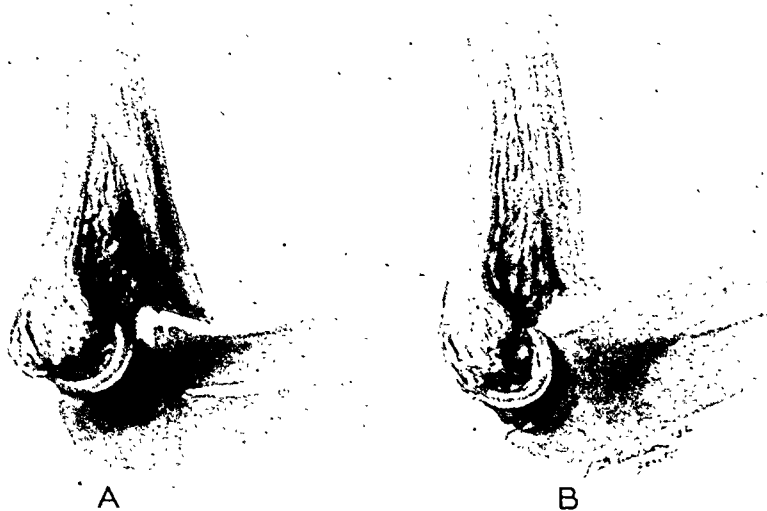


FIG. 5. Old supracondylar fracture showing absorption of projection into antecubital space; A, five months after injury; B, three years after injury. (Courtesy of Dr. J. W. White.)

If in addition the lower fragment is displaced to the medial side and rotated, producing a varus deformity, an osteotomy through the original fracture site may be necessary for the restoration of normal

The treatment is then that of a fresh supracondylar fracture of the extension type, the elbow being immobilized in hyperflexion. At times there is danger that the fragments may slip apart, and it



may be necessary to hold them together by inserting a bone peg through the lower into the upper fragment.

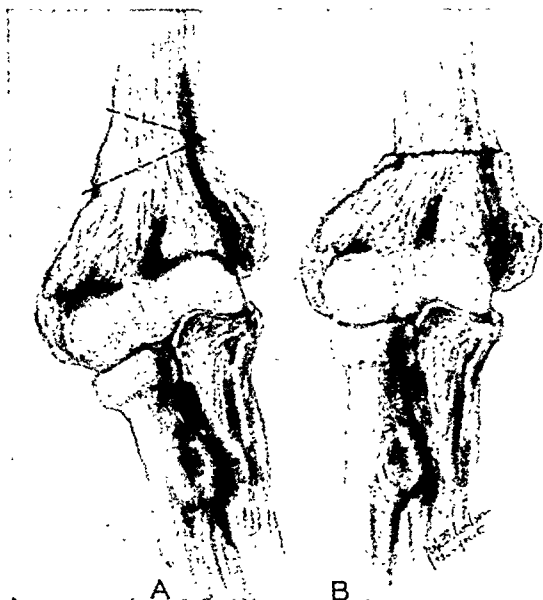


FIG. 6. Old supracondylar fracture with cubitus varus deformity; A, note position of wedge osteotomy; B, after osteotomy showing correction of varus deformity.

It may be necessary to remove bone which projects posteriorly following the

if there is rotation and medial displacement of the lower fragment. Occasionally the osteotomy is best done through a posterior approach, in which event the triceps muscle should be split.

Occasionally a marked anterior angulation follows supracondylar fracture (Fig. 7). In such cases anterior cuneiform osteotomy should be done. This will increase both flexion and extension of the joint. The postoperative treatment is that of a fresh supracondylar fracture.

The treatment of old unreduced epiphyseal displacements resulting in deformity is the same as that of supracondylar fractures.

Cohn has called attention to the development of the external rotators of the humerus in supracondylar fractures with cubitus varus deformity. He believes that if the external rotators of the humerus are not strengthened after the osteotomy and correction of the deformity, a tendency toward recurrence of the varus, of muscular rather than bony origin, will result. Cohn also believes that at times it is wise to put a drain into these joints after the

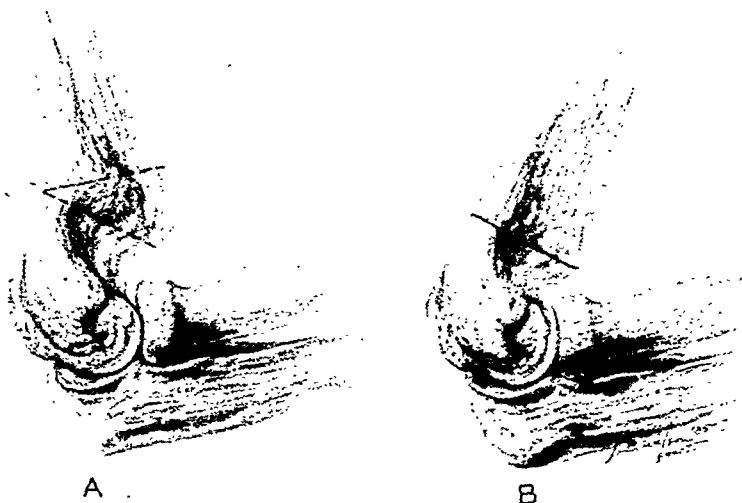


FIG. 7. Old supracondylar fracture with anterior angulation; A, note anterior bowing with position of wedge osteotomy; B, after osteotomy showing correction of angulation.

malunion of a flexion supracondylar fracture. An osteotomy also may be indicated

osteotomy in order to prevent the excessive swelling which sometimes ensues. If swell-

ing does occur it may be necessary to decrease the amount of flexion, and thereby the position of the fragments may be lost.

of the external condyle may be followed, however, by the formation of excessive callus and an abnormal amount of fibrous tissue

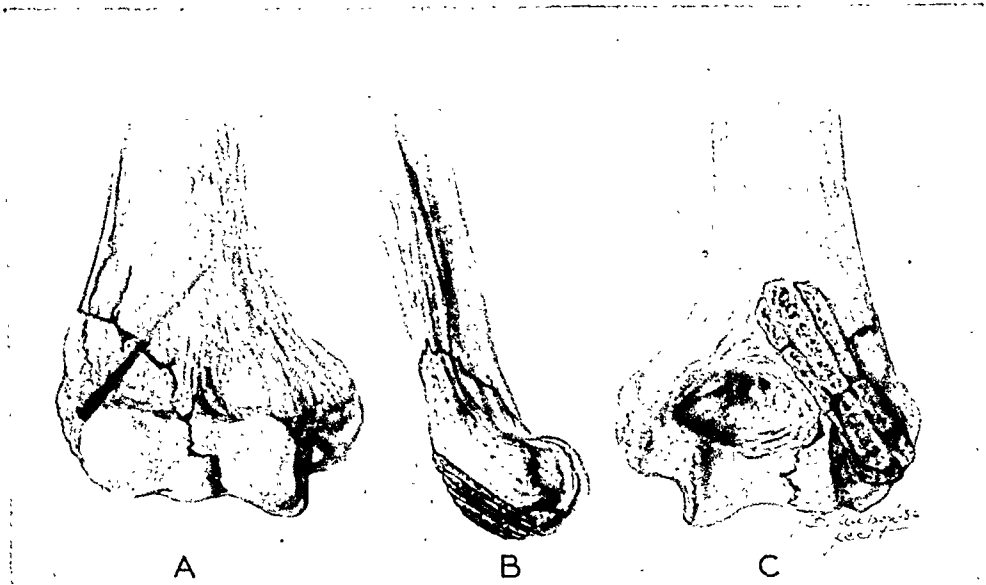


FIG. 8. Old fracture of external condyle; A, after operation; note small nail used to hold fragment in place; B and C, lateral and posterior views showing osteoperiosteal grafts. (After Campbell, Speed and Macy.)

Osteotomy for malunited supracondylar fracture may be done through a lateral or medial incision, the choice depending upon the type of fracture and the character of the displacement. If the osteotomies are done with careful dissection and minimal trauma the results are almost uniformly satisfactory. In all osteotomies about the elbow joint care should be taken to isolate the adjacent nerves and protect these from injury. It is often necessary to carry out transposition of the ulnar nerve from the posterior to the anterior aspect of the elbow.

#### FRACTURES OF THE EXTERNAL CONDYLE

Fracture of the external epicondyle is observed rarely. Occasionally the detached epicondyle fails to unite; when non-union is associated with pain the fragment should be excised. Fractures involving the anterior articular surface of the capitellum will be discussed as a separate group.

The external condyle, unlike the internal condyle, does not function in flexion and extension of the elbow joint and hence is not essential to elbow motion. Fracture

which limits the anteroposterior mobility of the joint. Most of the late fracture deformities in this area consist of detached external condyles which are adherent to the shaft of the humerus by fibrous tissue. The non-union is due to displacement and rotation of the condylar fragment. It has been said that displaced fractures of the external condyle should always be reduced by open operation. Only occasionally in the presence of displacement is it possible to secure by closed manipulation a reapproximation sufficiently accurate to insure a good result. In children, owing to the large amount of cartilage covering the bone, it is impossible to tell from the roentgenogram the extent of the fracture and the amount of the displacement. In the open reduction of this fresh fracture the condylar fragment should be accurately replaced and, if necessary, maintained in the corrected position by the use of small nails or autogenous or beef bone pegs. Any soft tissue attachment which may be present should be preserved, in order to insure a blood supply to the condylar fragment, although at times the preserva-

tion of a soft tissue connection is impossible. Occasionally fixation is secured by means of catgut sutures.

face of the humerus improved, and most or all of the valgus deformity corrected.

In adult cases it is often best to excise

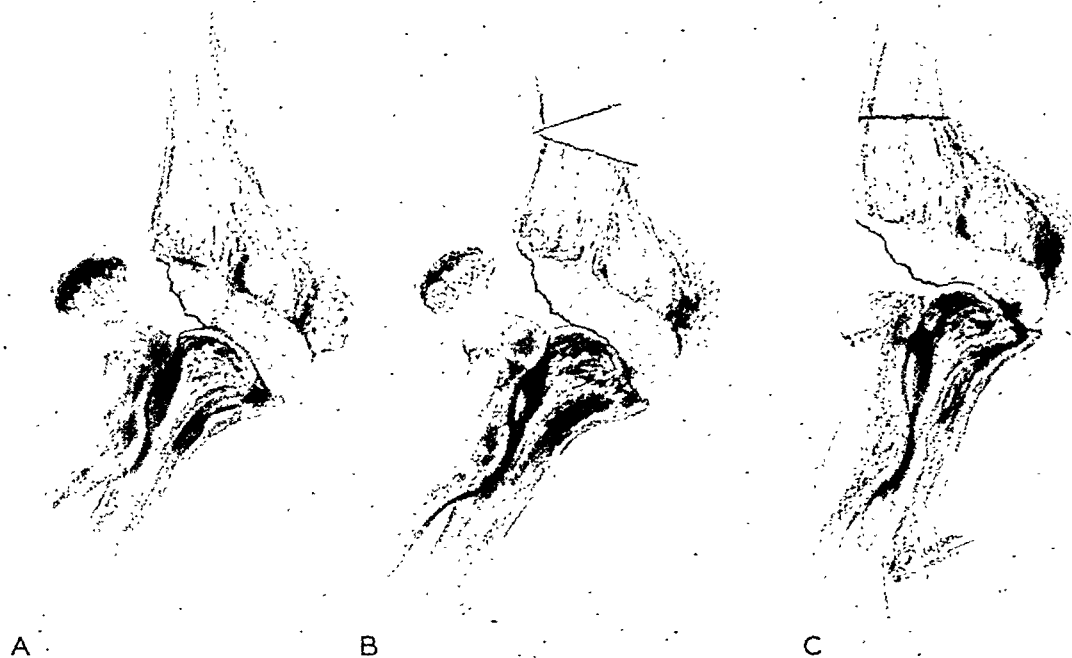


FIG. 9. Old fracture of external condyle of humerus with detached fragment and cubitus valgus deformity; A, before operation; B, showing position of wedge osteotomy; C, after operation; note correction of valgus deformity and removal of detached external condyle.

In old malunited fractures of the external condyle, occasionally it is possible and advisable to replace the condylar fragment. Sufficient bone should be removed from the fragments to secure freely bleeding surfaces, and either a nail or a peg should then be used to hold the fragments in place. Campbell, and Speed and Macey have recommended that osteoperiosteal grafts be placed over the posterolateral surface of the fragments after preparation of a suitable bed of raw bone (Fig. 8).

When valgus deformity is associated with ununited fracture of the external condyle, it may be advisable to perform a wedge osteotomy of the lower portion of the shaft of the humerus, the base of the wedge pointing medially (Fig. 9). In this way the level of the internal condyle is raised, the position of the articular sur-

the fractured external condyle and to make no attempt to replace it in normal position. Since many of the old cubitus valgus cases develop irritation of the ulnar nerve (discussed further under "Complications"), it is often advisable to follow excision of the condylar fragments by an anterior transposition of the ulnar nerve.

Fracture of the external condyle in a growing child, unless reapproximation is effected promptly, invariably results in cubitus valgus which becomes more marked as the child grows older. In such cases a wedge osteotomy is often advisable, the base of the wedge being placed well above the epiphyseal line on the medial side. In children removal of the external condyle is followed by a progressively increasing valgus deformity due to continued growth of the epiphysis of the internal condyle.

A series of cases in children reported by Speed and Macey shows the final results of replacing the external condyle several months after fracture to be very disappointing. Growth changes occur which lead to deformity and impaired function. When nailing of the external condyle is necessary in children, care should be taken to avoid putting the nail through the epiphyseal line. Bouman states that in fracture of the external condyle or capitellum the fragment or fragments should be removed, because of the possibility that they or the callus which forms about them may restrict the range of motion of the elbow.

Ashhurst reports the case of a boy of five years who was first examined five months after sustaining a fracture of the external condyle. A cubitus varus deformity, which is unusual in this type of injury, had developed. At operation the external condyle was found to be both rotated and displaced downward and backward, and a sufficient portion of the condyle was removed to permit extension and to overcome the varus deformity. The olecranon fossa was deepened to allow full extension, and the raw lateral surface of the external condyle was covered with fatty tissue. Three and a half years later, when the patient was eight and a half years old, there was no varus deformity and the range of extension and flexion was normal. Ashhurst also reports the case of a girl, aged nine years, who had had a fracture of the external condyle two years previously, resulting in complete detachment and anterior and outward rotation of the condylar fragment. Slight valgus deformity was present at operation. The condyle was chiseled to healthy bone and affixed with chromic catgut with the arm in full extension and supination. Two and a half years later firm union had occurred and there was a normal carrying angle and a normal range of joint motion. These cases are unusual but certainly show that excellent results can be obtained with the proper operative procedures.

Key and Conwell state that in adults it is always best to remove the external condyle, since owing to degeneration of the cartilage it is no longer suitable for function as an articular surface. In children they recommend always an attempt at replacement of the external condyle, because of the fact that the growth changes which follow its excision may lead to marked deformity.

#### FRACTURE OF THE INTERNAL CONDYLE

Because of its rarity, fracture of the internal condyle does not constitute so important a problem as the supracondylar or the external condylar fracture. The internal epicondyle or epitrochlea is fractured more often than the condyle or the trochlear surface. The epicondyle frequently remains unattached and later must be removed if limitation of motion and pain develop. Because of the articulation of the trochlea with the coronoid fossa of the ulna, fractures of the internal condyle are much more likely to be followed by limitation of motion than are fractures of the external condyle. Restriction of motion is particularly likely to result when there is much displacement of the internal condyle. Malunited fracture of the internal condyle usually leads to ankylosis, and arthroplasty is necessary before motion can be obtained.

After fracture of the internal condyle, bone may form within the elbow joint and cause locking. Excess bone formation is a very common sequel. Extension of the elbow is often restricted by the filling up of the olecranon fossa by callus.

Key and Conwell state that accurate reposition of the internal condyle should be carried out because it is essential to a good functional result. If the ulna is articulating in any way with the displaced internal condyle, however, it may be wise to leave the position of the condyle unchanged and to restore the alignment by an osteotomy of the humeral shaft. In such cases it is sometimes advisable to remove the normal external condyle since

it is not required for flexion or extension and is not essential to rotation of the forearm.

autogenous bone pegs. The condyles are first fixed to each other; another peg is then put through one condyle and up

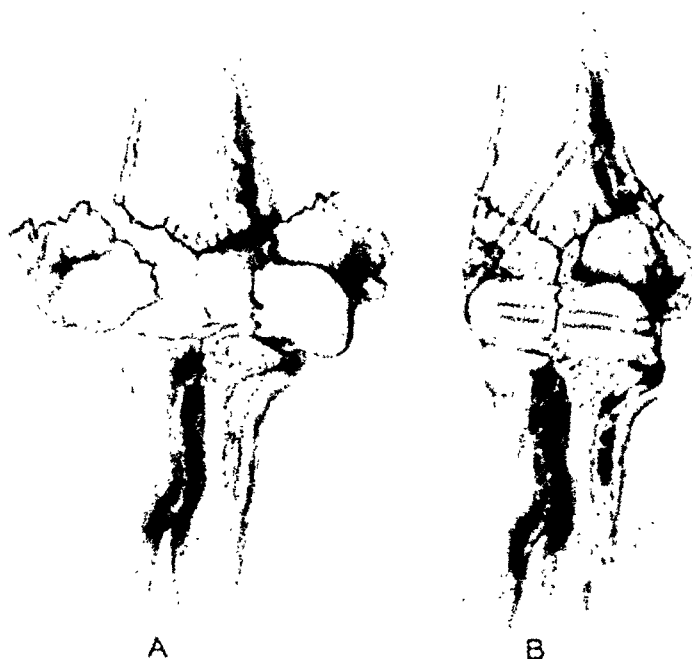


FIG. 10. Intercondylar  $\tau$  fracture of lower end of humerus; A, note wide separation of fragments; B, after open reduction showing beef bone pegs and wire. (After Kellogg Speed.)

#### INTERCONDYLAR FRACTURES

This group includes all fractures which involve both condyles, of which the most important are comminuted "T" and "Y" types. This group undoubtedly includes most of the fractures which result in marked disability of the elbow.

When it is possible to reapproximate the condyles and reconstruct the joint, this should be done. Kellogg Speed reports several satisfactory results with the following technique (Fig. 10): an incision is made on each side of the joint above the condyles; the external condyle is freed and fastened to the shaft by an ivory peg or nail and the internal condyle may be fixed to the shaft by wire. In addition it may be necessary to wire or nail both condyles together. Accurate approximation minimizes the danger of subsequent bony ankylosis.

Campbell has recommended a similar type of reconstruction with the use of

into the shaft of the humerus. When the condyles are extensively comminuted, the major fragments should be fixed in as nearly a normal relationship as can be secured. At times it is necessary to remove some of the smaller fragments. It is sometimes impossible to approximate the fragments accurately enough to create a new joint; in such cases resection is justifiable.

In occasional malunited intercondylar fractures it is only necessary to replace a single fragment; this is usually the internal condyle. If there is much deformity of the arm it may be necessary also to carry out an osteotomy.

A great many intercondylar fractures lead to complete or almost complete ankylosis of the joint. MacAusland has said that arthroplasty is indicated when the range of motion in such joints is 10 degrees or less. Key and Conwell state that an arthroplasty is nearly always necessary when there has been severe comminution

with the development of deformity and ankylosis.

Campbell states that in severely comminuted elbow fractures arthroplasty is indicated when the joint is destroyed so extensively that other operations are unsuitable, and when ankylosis has taken place without loss of the contour of the condyles. He further states that arthroplasty is seldom advisable in children. Occasionally, however, a child whose elbow has become ankylosed in full extension or in a position of disabling angulation is best treated by an arthroplasty of a modified type.

It is nearly always possible to improve both the function and the appearance of these joints if the procedure is chosen with judgment and the operation is effected without excessive traumatization.

#### FRACTURES OF THE ARTICULAR SURFACES OF THE CAPITELLUM AND TROCHLEA

This type of fracture is rare. Anatomically the capitellum and the trochlea are parts, respectively, of the internal and external condyles. Often only the anterior joint surface is fractured, especially in the case of the capitellum. Such a fracture is spoken of as "fractura rotuli humeri." The small fracture fragment is always displaced into the joint space (Fig. 11). Lindem, after reviewing the literature, has enumerated the following five clinical evidences of these fractures: (1) spontaneous pain in the region of the fracture; (2) normal elbow landmarks; (3) progressive limitation of flexion-extension motion to approximately 15 degrees; (4) a palpable bony projection in the antecubital fossa; and (5) crepitus caused by a loose body within the joint.

The treatment of the old fracture is removal of the displaced articular fragment. Excision should be done in the fresh fractures as well. Occasionally in young children, however, the fractured epiphysis of the capitellum can be replaced and fixed with chromic catgut sutures. Wilson reports an ununited fracture of the capitellum

in which the fragment was replaced and fixed with a small bone graft; this resulted in an improved joint. Such cases, however, are unusual.

#### THE ANATOMIC VERSUS THE FUNCTIONAL RESULT

Joint structures are of little use if function is lost. The usefulness of joints is in direct proportion to their range of painless motion. Anatomic reposition of fragment after a fracture is to be desired, but the attempt to obtain this result should not be carried to the point of impairing or in any way risking the functional recovery.

This is especially true in children during the periods of active growth. Wilson has said that in children bony consolidation after fracture about the elbow always takes place; even when in the beginning there is an ugly deformity which seems to block the flexion of the elbow, the restriction of motion is eliminated in the course of time as growth at the lower epiphysis elongates the humerus and pushes the elbow away from proximity to the point of injury.

The loss or increase of the carrying angle is of little significance if function be preserved. Parents are most anxious, especially when the patient is a girl, to obtain recovery without deformity. It is much better, however, for the child to grow up with the ability to use the elbow normally than with a joint of normal appearance but limited use.

Cotton has stated that after fracture about the elbow in children he has rarely found ankylosis or any extensive loss of motion. He further states that even astonishing degrees of deformity due to inaccurate reposition may be followed in six months by good function. This is occasionally the case in adults. Often after intercondylar fracture the elbow remains broadened but its function becomes normal.

In cubitus valgus limitation of motion is rare. In cubitus varus motion is nearly always restricted.

König has shown that in children even marked deformities disappear after several years of absorption of bone and the filling



FIG. 11. Fracture of capitulum with anterior displacement.

up of its defects, and that only rarely does limitation of function result.

Ashhurst feels that when the elbow possesses a range of motion of from 50 to 150 degrees there is little disability. He also states that deformity alone is rarely a cause of disability. Ashhurst also calls attention to the fact that marked degrees of varus deformity usually weaken the elbow enough to impair its function, whereas slight degrees of cubitus varus are inconspicuous and cause no disability.

Gilcreest writes, "As structure is subservient to function, it is only natural to presume that the maximum return of usefulness in a limb would be brought about by the exact reconstruction of the deformed bone, but as perfect reduction is not infrequently impossible or inexpedient, our chief aim should always be complete restoration of function."

The clinical evidence and the opinions reviewed emphasize the fact that a good functional result is preferable to anatomic reposition of the fragments when such reposition necessarily entails impairment of function. Results in the treatment of fractures in the region of the elbow would be better if there were a more widespread appreciation of these fundamental principles of their care.

## COMPLICATIONS

Complications of fractures of the lower end of the humerus are observed oftener in association with malunited fractures than with fresh fractures. Nerve injuries, Volkmann's ischemic paralysis, and traumatic myositis ossificans are the three most frequently observed complications. Excessive callous formation is occasionally a serious complication. Fortunately these complications are all uncommon and are observed in only a very small percentage of the total number of fractures about the elbow. In the present discussion space permits only a brief description of these complications and their symptomatology and treatment.

The *nerve injuries* probably form the largest group of complications. The ulnar nerve is involved more frequently than the median or radial. The ulnar nerve may be injured as a result of trauma at the time of the fracture, the lesion consisting of a partial or complete rupture; this occurs most commonly in association with fracture of the internal condyle. The nerve may be constricted by exuberant callus, or it may be traumatized gradually as the late result of a fracture of the external condyle which has been followed by the development of a valgus deformity: this results in delayed ulnar nerve palsy. Irritation of the nerve is due to the constant stretching and friction which it undergoes in the ulnar groove at the distorted elbow; often a small bulbous swelling of the nerve trunk appears at the point of irritation. The treatment of ulnar nerve injuries is the removal, when possible, of the causative factor. If a complete tear or rupture is suspected, the nerve should be explored and an attempt made to reapproximate its ends. If the nerve is caught in callus in or about the ulnar groove, it should be freed and transplanted to an anterior position, where it should be covered by fat and fascia. In delayed ulnar nerve palsy also, the nerve should be transplanted anteriorly. Any bulbous thickening of the nerve trunk

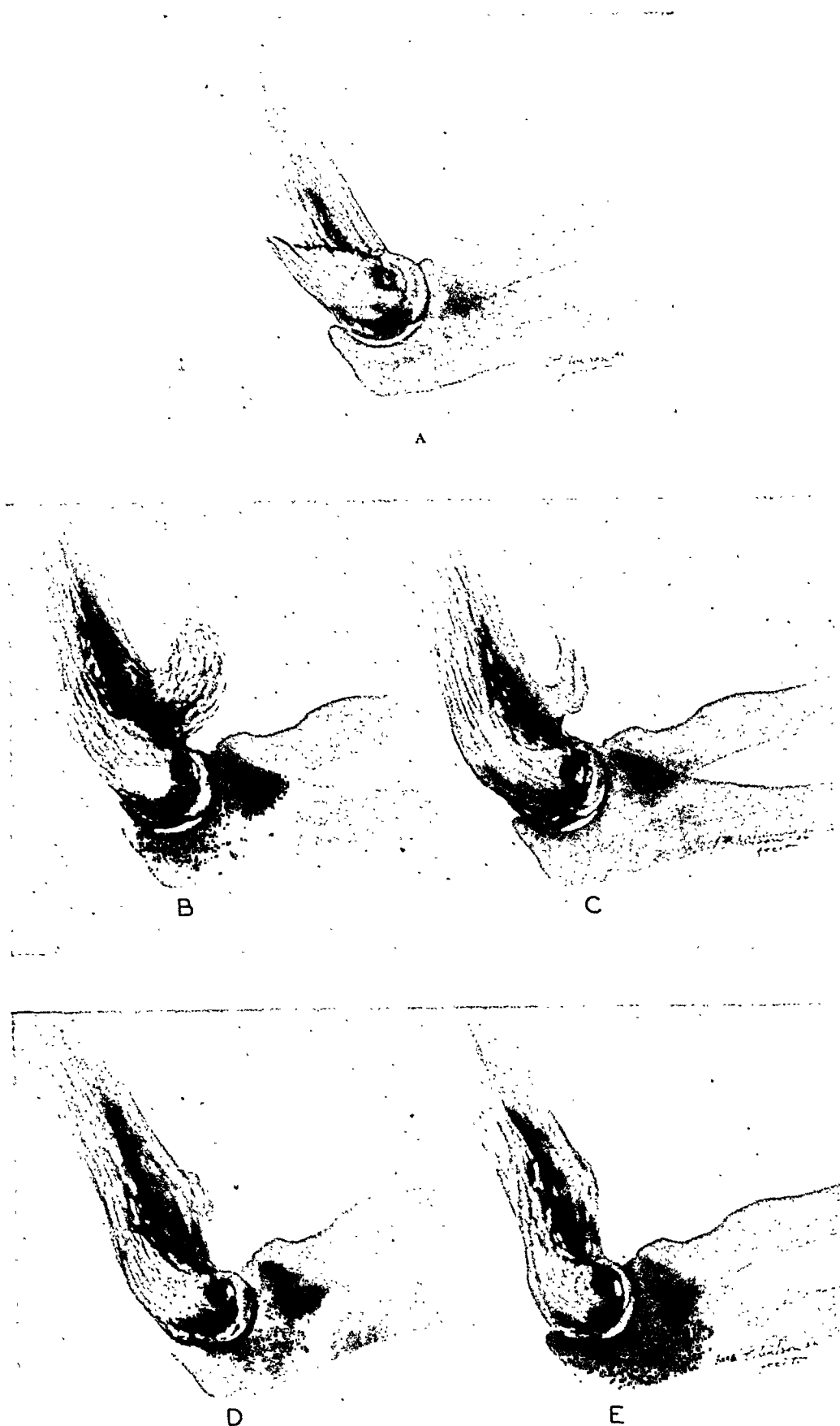


FIG. 12. Supracondylar fracture showing absorption of calcified mass; A, original fracture (after Bristow); B, three weeks after fracture; C, two months after fracture (after Bristow); D, four months after fracture; E, nine months after fracture with almost complete disappearance of calcified mass with rest. (After Bristow.)



should be excised, and the cut nerve ends should be reapproximated.

The median and radial nerves are seldom injured in fractures of the lower end of the humerus while the radial nerve is often injured in fractures of the head and neck of the radius. In most of these nerve injuries exploration is indicated; transposition is carried out if it appears advisable to remove the nerve from some projecting bone fragment or exuberant callous formation.

The *Volkman's ischemic palsies* are undoubtedly the most serious complications of elbow fractures. They develop with extreme rapidity, resulting presumably from interference with the venous return from the forearm. Rapid degeneration of the fibers of the flexor muscles of the forearm is followed by fibrosis and contracture. These ischemic palsies may be caused by too tight bandaging but occasionally have been observed when no splint or dressing has been applied. In such cases the palsy results from the extravasation of blood into the antecubital space, where it is retained within a closed compartment formed by the fascial structures. The resulting distention causes compression of the antecubital blood vessels. When circulatory disturbances in the forearm and hand indicate that such changes are taking place, immediate relief of the pressure should be accomplished by operative evacuation of the extravasated blood. This is often the means of saving an arm or hand. When ischemic palsy has developed, treatment is at best unsatisfactory.

*Traumatic myositis ossificans* occurs most commonly in association with old posterior dislocations of the elbow. Occasionally, however, it is found as a complication of old fractures of the lower end of the humerus. Unmistakable limitation of motion is always present. Calcification is usually found within the brachialis anticus muscle; it may occur, however, in any place in or about the elbow joint. Myositis ossificans often follows a tear or stripping

of the periosteum. It is impossible to foretell its development. After the presence of myositis ossificans has been proved by roentgenographic examination and sometimes by palpation, the elbow should be immobilized for a period of weeks or months. This is the best means of insuring absorption of the calcification. If the absorption does not take place after prolonged immobilization, it is advisable to explore and remove the excess bone in order to obtain increased motion and function in the joint. It is most inadvisable to attempt to manipulate or force motion in the presence of myositis ossificans, since manipulation usually increases the amount of calcification and results ultimately in more harm than good (Fig. 12).

#### SUMMARY

1. The commonly used methods of operative treatment of malunited fractures of the lower end of the humerus have been reviewed.
2. Emphasis has been placed upon the importance of a good functional result in preference to perfect anatomical reposition with questionable improvement of function.
3. A few of the common complications of malunited fractures of the lower end of the humerus have been discussed briefly.

#### REFERENCES

- ASHHURST, A. P. C. An Anatomical and Surgical Study of Fractures of the Lower End of the Humerus. Phila., Lea & Febiger, 1910; Operations for old fractures of the elbow. *Med. and Surg. Rep. Episcopal Hospital, Phila.*, 1: 279, 1913.
- BOUMAN, H. A. H. A study of the fractures of the lower extremity of the humerus. *Surg., Gynec. and Obst.*, 27: 58, 1918.
- BRISTOW, W. R. Myositis ossificans and Volkmann's paralysis. *Brit. Jour. Surg.*, 10: 475 (Apr.) 1923.
- CAMPBELL, W. C. Malunited fractures and unreduced dislocations about the elbow. *J. A. M. A.*, 92: 122 (Jan. 12) 1929.
- COHN, I. Ankylosis of the elbow: its prevention and treatment. *South. Med. Jour.*, 17: 511 (July) 1924; Observations based on a study of injuries to the elbow. *Arch. Surg.*, 3: 357 (Sept.) 1921.
- CONWELL, H. E. Treatment of acute comminuted fractures about the elbow joint: report of 60 cases. *South. Med. J.*, 20: 579 (Aug.) 1927.
- COTTON, F. J. Dislocations and Joint Fractures. Phila., W. B. Saunders Co., 1924.

- EIKENBARY, C. F. Fractures of the elbow, through or near the lower epiphysis of the humerus. *Jour. Bone and Joint Surg.*, 10: 757 (Oct.) 1928.
- EISENDRATH, D. N. Keen's Surgery, Its Principles and Practice. Phila., W. B. Saunders Co., 1919, Vol. 11, p. 184.
- ELIASON, E. L. Fractures of the Humerus, Radius and Ulna (Surgical Monographs). N. Y., D. Appleton & Co., 1925.
- GHORMLEY, R. K. and MROZ, R. J. Fractures of the humerus: end results from treatment. *Surg., Gynec. and Obst.*, 60: 730 (Mar.) 1935.
- GILCREEST, E. L. Fractures of the elbow joint and of the lower end of the humerus. *Surg., Gynec. and Obst.*, 37: 452 (Oct.) 1923.
- JONES, SIR R. Injuries to Joints. Oxford Univ. Press, Ed. 3, 1930.
- JONES, S. G. Volkmann's contracture. *Jour. Bone and Joint Surg.*, 17: 649 (July) 1935.
- KEY, J. A. and CONWELL, H. E. Fractures, Dislocations and Sprains. St. Louis, C. V. Mosby Co., 1935.
- KÖNIG, F. Die späteren Schicksale difform geheilter Knochenbrüche, besonders bei Kindern. *Arch. f. klin. Chir.*, 85: 187, 1908.
- LINDEM, M. C. Fractures of the capitellum and trochlea. *Ann. Surg.*, 76: 78, 1922.
- MACAUSLAND, W. R. In discussion of Isidore Cohn's paper. *South. Med. Jour.*, 17: 511 (July) 1924.
- POTTS, W. J. The treatment of supracondylar fracture of the humerus. *Ann. Surg.*, 89: 607 (Apr.) 1929.
- ROBERTSON, R. C. and BOGART, F. B. Fracture of the capitellum and trochlea combined with fracture of the external humeral condyle. *Jour. Bone and Joint Surg.*, 15: 206 (Jan.) 1935.
- SEVER, J. W. and GALLUPE, H. I. Fracture of the elbow. *J. A. M. A.*, 98: 1737 (May 14) 1932.
- SINCLAIR, M. Fractures. London, Constable & Co., 1931.
- SIRIS, I. E. Elbow fractures and dislocations: treatment and analysis of 181 cases at Bellevue Hospital. *Surg., Gynec. and Obst.*, 40: 665 (May) 1925.
- SMITH, M. K. Fractures of the external condyle of the humerus with rotation. *Ann. Surg.*, 86: 304 (Aug.) 1927.
- SPEED, J. S. and MACY, H. B. Fractures of the humeral condyles in children. *Jour. Bone and Joint Surg.*, 15: 903 (Oct.) 1933.
- SPEED, K. Fractures and Dislocations. Phila., Lea & Febiger, 1928.
- STIMSON, L. A. Fractures and Dislocations. Phila., Lea & Febiger, Ed. 8, 1917.
- TYLER, G. T. Supracondylar fracture of humerus: late result of operation for malunion. *Am. Jour. Surg.*, 7: 867 (Dec.) 1929.
- WALTON, A. J. Fractures and Separated Epiphyses. London, Edward Arnold, 1910.
- WILSON, P. D. Fractures and dislocations in the region of the elbow. *Surg., Gynec. and Obst.*, 56: 335 (Feb.) 1933.



# PULMONARY EMBOLISM\*

## GENERAL SURGICAL ASPECTS AND MEASURES FOR PREVENTION BASED ON A REVIEW OF THE LITERATURE

ARTHUR BOWEN, M.D.

LOS ANGELES, CALIFORNIA

**L**ITTLE has been added to the symptoms and genesis of pulmonary embolism as described by the surgical pathologists, Virchow and Welch. Recent literature has dealt with the statistical data revealing the frequency of occurrence; while only in the past few years have preventive, prophylactic measures been advocated, notably by Walters and Bancroft.

Aschoff's<sup>2</sup> view on the origin of embolism and thrombosis are accepted as authoritative. He believes that the etiological factors are complex, and that no single factor is responsible for its formation. The conditions which precede thrombosis he catalogues as: (1) changes in the blood plasma; (2) changes in the blood elements; (3) changes in the blood flow; (4) changes in the vessel wall itself.

The cause of the high incidence of vascular thrombosis leading to pulmonary embolism in surgical cases as compared with medical cases is still obscure. While the medical cases occur in patients with debilitated or failing hearts—the surgical cases are usually observed in young or middle aged with normal hearts. The implication is—that the surgical procedures per se, or their sequelae, are responsible for the occurrence of pulmonary embolism (Allen).<sup>1</sup>

### STATISTICAL ANALYSIS

Analytical reports from surgical clinics reveal the following interesting facts:

**Incidence.** Henderson<sup>13</sup> reported the incidence of fatal pulmonary embolism among surgical cases that came to necropsy at the Mayo clinic during 1917–1927 as 6 per cent.

There has been a definite and progressive increase in the incidence of thrombosis and embolism in the past decade. Nordmann<sup>21</sup> reports that in 1924 the incidence increased from 2 to 3 per cent, and in 1927 to 4.5 per cent. In the Giessen Clinic, Glahn<sup>11</sup> reports that a most marked rise began in 1925, during which the mortality from fatal cases of embolism increased 10 per cent. Bodon<sup>5</sup> states that according to his statistics the incidence has been four times as high since the war than in the period from 1911 to 1913. Kuhn, quoted by Walters,<sup>30</sup> reported the incidence of fatal embolism in Germany from 1924 to 1927 increased from 1.3 to 4.9 per cent, and that in 1927 thrombosis was found in every fourth necropsy, and fatal embolism in every twentieth body.

**Age.** Nicolaysen<sup>21</sup> reported that post-operative embolism is rarely found in patients under twenty years of age. The majority of fatal cases are well advanced in years, usually above the age of sixty. Killian, in a review of the Mayo Clinic statistics found the average age of patients affected to be higher than that of all other patients.

**Sex.** In the 51 cases of fatal pulmonary embolism in the Giessen clinic the ratio of males to females in Glahn's<sup>12</sup> statistics was 31:20.

**Weight.** Snell,<sup>27</sup> in a study of postoperative deaths of obese patients in the Mayo Clinic, found pulmonary embolism to be a more common cause of death than of the average patient. He states, "It suggests, but does not prove that obesity, per se, increases the liability of this com-

\* Presented before the General Staff of the Cedars of Lebanon Hospital, Los Angeles, California, as part of a Symposium on Pulmonary Embolism, May, 1935.

plication. Difficulty of operation with the unusual trauma may be a factor; mild circulatory failure with resultant stasis might conceivably be more common in obese persons." Of the 84 patients who developed embolism in the Giessen Clinic, Glahn<sup>12</sup> reports 30 per cent were obese, 22.5 per cent were well nourished, and 41.5 per cent were cachectic.

*Type of Operation.* Walters<sup>29</sup> found that abdominal and pelvic surgery leads the list in about 70 per cent of cases. Stomach surgery, especially for cancer, and pelvic surgery, particularly operations for prostatic hypertrophy and fibroids of the uterus, are most important. Thyroid surgery is particularly free from postoperative embolism. Surgery of the extremities is rarely complicated by embolism. Henke called attention to the fact that otorhinological surgeons never see cases of acute fatal pulmonary embolism although they often see thrombosis formation in the great brain sinuses. After craniotomy acute embolism is very rare.

*Anesthesia.* It was formerly believed that a general anesthesia, especially ether, was a factor in causing embolus, but embolism cases are as frequent following local and regional anesthesia as in general anesthesia.

*Preoperative Condition.* According to Walters,<sup>30</sup> evidence that the formation of thrombosis and embolism in debilitated patients is frequent, is found in the fact that the incidence of fatal pulmonary embolism was three times greater after cystotomy preliminary to prostatectomy on debilitated patients than after the same operation performed on patients in good condition.

Kazda and Strocher<sup>14</sup> in a study of the autopsy material of the Pathological Institute of the University of Vienna noted the presence of cardiac changes in more than one-half of the cases of fatal postoperative embolism. Involvement of the respiratory organs, liver, and biliary tract was also found in about 50 per cent. These authors conclude that the surgical procedure superimposed upon the primary disease and the associated anatomical

changes in the internal organs favored a distant thrombosis.

*Infection.* In Freund's<sup>10</sup> opinion, the importance of infection in the development of thrombosis has been overestimated. This is indicated by the rarity of thrombosis in long continued suppurative conditions, and its occurrence following completely aseptic operations. Lockhart-Mummery<sup>18</sup> states that sepsis is not necessarily an important factor in thrombosis.

*Thrombophlebitis.* It is significant that throughout the literature, relatively few cases of fatal pulmonary embolism were seen associated with thrombophlebitis clinically recognized. The concensus is, that when the clinical phenomena of thrombophlebitis appears, a clot has been formed which is not friable, and only small emboli are thrown off. So that *fatal embolism* is rare, but *infarctions* are common.

*Intravenous Fluids.* Huebschmann, in discussing Nordmann's<sup>21</sup> study of 143 cases, warned against the indiscriminate use of intravenous injections. Laven stated that he had often known thrombosis of the basilic vein to develop after continuous intravenous infusion. On the other hand, Bancroft<sup>3</sup> states he has been unable to find any increase in clotting elements of the blood after intravenous glucose administration.

*Drainage.* When thrombosis occurs in cases in which drainage is established, it develops from two to four days later, and the course is less severe than in cases without drainage, state Miller and Roepke.<sup>19</sup>

*Seasonal Variation.* No relationship between the season of the year and the occurrence of thrombosis and embolism was noted by Glahn.<sup>12</sup>

*Lung Involved.* The ratio of the right lung involvement to the left lung is 4:3. Pulmonary embolism occurs particularly often in the right lower lobe, reported Miller and Roepke.<sup>19</sup>

*Origin.* Fifty per cent of postoperative emboli have their origin in the femoral or iliac veins. Farr and Spiegel<sup>8</sup> in 16 autopsied

cases found that thrombosis occurred in the femoral, internal iliac, or common iliac veins, and more frequently on the left side than the right.

*Occurrence.* Fatal-pulmonary embolism usually occurs at the end of the second week following surgery.

While this data has shown us the types of operations and the types of patients which are most prone to result in embolism, they have not shed any light on the etiology or prophylaxis. In order to study the problem best, we can arbitrarily divide these causes into two groups: (1) those caused by *physical* factors, and (2) those caused by *biochemical* factors.

It is generally conceded that trauma, infection, slowing of the blood stream and dehydration, predispose towards thrombosis. There must, however, be another factor inherent in the individual of a *biochemical* nature, which tends to make that individual more susceptible to thrombosis and embolism.

Let us discuss the physical factors which are concerned in the etiology and practical measures which have been used in the treatment of operative cases to reduce the incidence of embolism. Also, to discuss the studies made on the clotting factors of the blood, and to suggest certain lines of treatment which have been found to diminish clotting tendencies after operation.

The outstanding single physical factor is the slowing of the blood stream, with stasis of blood in the pelvic veins. Almost all pathologists and surgeons agree that slowing of the blood stream is one of the primary factors in the production of thrombosis.

It has been shown that thrombosis rarely occurs in arteries because the blood flow is too rapid. Fifty per cent of fatal postoperative emboli have their origin in the femoral or pelvic veins. While occasionally thrombosis may occur because of direct trauma, or from mass ligation, however, in most instances these veins are not in the immediate field of operation. The underlying cause is the slowing of the circulation in the veins. The factors which may slow the blood stream in the large

veins occur commonly in surgical patients. Among the most important are: (1) loss of blood; (2) shock; (3) loss of fluids—with preoperative purgation, postoperative fluid restriction, increased sweating, and vomiting, there is a marked increase of fluid output over intake, with a resultant increased viscosity of the blood; (4) weak heart action following surgery; and (5) interference with the action of the respiratory movements due to tight bandaging and splinting of the abdominal muscles.

Any method which will cause an increase in metabolism, rate of blood flow or blood pressure, should decrease the incidence of embolism. Thyroid effectively increases metabolism. Plummer's observation that in hyperthyroid patients thrombosis and embolism seldom occur, even when disturbances in blood flow due to the associated cardiac decompensation is present, led Walters<sup>29</sup> to institute a regime in which desiccated thyroid, grains 2, three times a day, is given postoperatively, with a marked reduction in the incidence in the 4500 cases done on his service.

In agreement with Walters, Freund<sup>9</sup> markedly decreased the incidence of embolism by thyroid administration. He reports one case of fatal embolism in 4000 operations. Even in prostatectomies, he has reduced the incidence to 0.2 per cent. Freund warns against the simultaneous use of thyroid and insulin in diabetics.

#### EXPERIMENTAL EXTRACORPOREAL THROMBOSIS

Shionoya, Johnson and Rowntree<sup>28</sup> reported on their experiments in the production of thrombosis by the use of an extracorporeal cannula loop, the cannula being inserted into the carotid artery and jugular vein of rabbits. Mechanical, physical and chemical factors were varied to determine the effects on rate and type of thrombus formation. The marked influence of slowing of the circulation on thrombosis was quickly recognized. They found that anything that tended to retard the circulation would hasten the process of thrombosis. Conversely, when circulatory stimulants as thyroxin or ephedrin were injected into

the animal, the circulation was maintained considerably longer than normal without clotting occurring in the cannula.

If venous stasis is the outstanding single factor in the etiology, what then, may be done to influence the circulatory stasis? The following measures are at our disposal: (1) careful preoperative preparation, especially in those of advanced years, providing aid through digitalis to a weak or failing circulation; and (2) reduction of fluid loss by omitting preoperative purgation; by providing adequate fluid intake, and avoiding unnecessary inanition.

*During Operation.* Careful operative technique; clean cut dissections; accurate hemostasis; avoiding mass ligatures, and avoidance of undue pressure on great veins by retractors.

*Postoperative.* 1. Adequate fluid intake by intravenous, rectal or subcutaneous routes;

2. Intelligent use of circulatory stimulants;

3. Tight bandages should be avoided; especially should the free mobility of the chest be preserved. If we consider that the return flow of blood in the vena cava is largely due to the suction of the heart and the respiratory movements, then the increased abdominal pressure due to postoperative distention and the splinting of the diaphragm must cause considerable stasis in the veins of the pelvis. With the use of the Gatch bed and Fowler's position, we have the double factor of gravity and constriction in the region of Poupert's ligament increased by the flexion of the thighs and the lower border of tight dressings, to embarrass venous flow;

4. Existing preoperative varicosities should be bandaged;

5. Position of the patient should be frequently changed to overcome stasis;

6. In abdominal cases every effort should be made to prevent and reduce postoperative nausea, vomiting, and gastric dilatation by the early use of the Levin tube, and energetic measures instituted for combatting intestinal paresis in peritonitis cases. Bancroft<sup>3</sup> believes that distention is lessened if food is given early. Alvarez

and others have shown that when a bolus of food passes through the pylorus, intestinal peristalsis is stimulated, which will carry with it gas as well as solid material. In uncomplicated cases, Bancroft routinely gives tea and toast the afternoon following the morning operation;

7. Routine employment of oxygen and CO<sub>2</sub> postoperatively for five minutes every two hours for the first twenty-four hours to prevent venous stasis by forcing deep respirations at a period when all vital functions are at low ebb;

8. Encouraging the use of early systematic exercises of the arms and legs, and especially daily elevation of the foot of the bed, as a mechanical method of increasing the venous flow from the dependent pelvic region. Pool,<sup>24</sup> in 1913, published an article on systematic exercise in postoperative cases in which he recommended exercises of the arms and legs be commenced the third day operative. Gamble<sup>11</sup> recently suggested using a pair of bicycle pedals mounted on a board base which can be placed conveniently for exercising the lower limbs.

Bettman of Leipzig, described a manual apparatus, a modified Perthe inflatable cuff which is attached to the bed, and controlled by a simple lever mechanism operated by raising and lowering the limb.

#### BIOCHEMICAL FACTORS

Evans<sup>7</sup> calls attention to the similarities between thrombosis following operation, parturition and the acute fevers. All of them follow tissue injuries with subsequent absorption of broken down products. In a study of the platelet count of postoperatives he found an increase from four to six days after operation, reaching its maximum about the tenth day, and then declining to normal during the subsequent ten days. He believed that the disintegration of the platelets provides material which is associated with the formation of thrombin, and the coagulation of fibrinogen.

Patey<sup>23</sup> argues that to prove the existence of a relationship between the numerical platelet increase and the liability

to postoperative thrombosis, it is necessary to prove that the operation of splenectomy is more liable to be complicated by thrombosis and embolism than other operations.

Koenig<sup>15</sup> believes that the vessel wall is injured by a toxin found in disintegrated muscle. He calls attention to the fact that thrombosis is most frequent in conditions accompanied by pronounced nuclear destruction, and in cases of tumor, inflammation and fracture. He believes detoxification can be accomplished by autogenous blood injections.

Allen<sup>1</sup> observed the blood changes following operation, and reported that fibrinogen is probably the most important of these changes. The number of platelets, cholesterol and bleeding time, showed no definite changes. The coagulation time and blood calcium showed slight variations. The number of erythrocytes and leucocytes, the prothrombin time, the fibrinogen and the lipoids showed definite and constant changes. The increase of leucocytes is significant because leucocytes are known to furnish thromboplastic substances that play an important part in coagulation.

Allen states "This non-specific physiologic change may partially explain the relatively high incidence of pulmonary embolism occurring in surgical patients as compared with non-surgical patients."

Bancroft and Stanley-Brown<sup>3</sup> performed experiments on dogs wherein vessels were ligated, causing necrosis of the organs they supply, such as the gall bladder and appendix and found an increase in the clotting factors of the blood.

Physiochemical studies made by Bancroft<sup>4</sup> and his associates over a period of years, have shown that patients with postoperative thrombosis and embolism have an increase of blood clotting elements in their blood. In studying the individual factors in blood clotting they found the following:

1. *Fibrinogen.* Experimental as well as clinical evidence seems to indicate that the concentration of fibrinogen within wide limits has little influence on clotting time. But inasmuch as any condition which brings about a concentration of the blood (such as dehy-

dratation) may show an abnormally high fibrinogen, and, as such blood has a high viscosity and is therefore subject to venous stasis, a condition favoring clotting . . . a high fibrinogen may indirectly indicate the possibility of danger from thrombosis.

2. *Calcium.* The independability of calcium in the clotting process has led to the belief that deficiencies or excesses of calcium must influence clotting. Clinically, normal blood calcium is found in hemophilia, and in the hemorrhagic diathesis of obstructive jaundice. In fact, there are no marked changes in the coagulation time in either the most marked hypocalcemia of parathyroid previa, or in the high blood calcium of hyperparathyroidism. No elevation in blood calcium has been demonstrated on spontaneous thrombosis.

3. *Thromboplastin.* This substance possesses the power of converting prothrombin into thrombin, in the presence of calcium. Unlike prothrombin, which appears to be limited to blood plasma, thromboplastin is widely distributed in the body. While platelets constitute the most important source of thromboplastin, it is probable that all cellular structures contain this substance, and liberate it when injured.

As the rate of clotting is dependent on the thrombin concentration in the blood it was their basis for developing a practical quantitative method of determining blood coagulation.

They<sup>4</sup> describe the technique of the plasma clotting test, which is a measure of the concentration of prothrombin and thromboplastin in the blood. They consider that 1.45 is the normal plasma clotting time. Using this time in seconds as the numerator, and the patient's plasma clotting time in seconds as the denominator, they obtain an index which they call the "plasma clotting index." This index normally ranges from 0.8 to 1.95. Readings below 0.8 are on the bleeding side, and those above 1.05 are on the clotting side.

They then attempted to determine whether the clotting factors could be changed by some therapeutic means. At the suggestion of Loeb of Columbia University, they used 10 c.c. of a 10 per cent solution of sodium thiosulphate intravenously, for three successive days. They

believe that sodium thiosulphate should be used prophylactically in patients having a high clotting index, and that it shortens the convalescence in cases of phlebitis. Its therapeutic value is prophylactic, rather than curative.

Mills<sup>20</sup> and Kugelmass<sup>16</sup> have shown that a carbohydrate and fat diet will raise the basal metabolism but will not increase blood clotting elements, while a protein diet not only raises metabolism but definitely increases blood clotting elements.

It is Bancroft's belief that in a number of cases, thrombosis and embolism may be aborted by administering a diet low in fats and carbohydrates, and the intravenous administration of sodium thiosulphate. In 1932 they reported 4250 operative cases treated under their regime with 11 cases of phlebitis, and no death from embolism.

#### CONCLUSION

In clinics where a definite prophylactic regime has been instituted both preoperatively and postoperatively, and drugs given to influence clotting factors, statistics show a marked decrease in the incidence of thrombosis.

#### SUMMARY

Until more definite facts are known concerning the chemistry of blood coagulation and the therapeutic control of clotting factors, our efforts must be aimed at the removal of factors which predispose to thrombosis, and most especially venous stasis in the large veins of the pelvis.

#### REFERENCES

1. ALLEN, E. V. Changes in the blood following operation. *Arch. Surg.*, 15: 254, 1927.
2. ASCHOFF, L. Lectures on Pathology. N. Y., Hoeber, 1924.
3. BANCROFT, F. W. and STANLEY-BROWN, M. Postoperative thrombosis, thrombophlebitis and embolism. *Surg. Gynec. and Obst.*, 54: 898 (June) 1932.
4. BANCROFT, F. W., STANLEY-BROWN, M. and QUICK, A. J. Postoperative thrombosis and embolism. *Am. Jour. Surg.*, 28: 648 (June) 1935.
5. BODON, G. The increase of fatal pulmonary embolism. *Orrosi beittl.*, 1: 29, 1931.
6. BROWN, G. E. Postoperative phlebitis. *Arch. Surg.*, 15: 245, 1927.
7. EVANS, W. H. Discussion on postoperative thrombosis. *Proc. Roy. Soc. Med.*, 22: 729, 1929.
8. FARR, C. E. and SPIEGEL, R. Pulmonary infarction and embolism. *Ann. Surg.*, 89: 481, 1929.
9. FARRAR, L. K. P. Postoperative embolism. *Surg. Clin. N. Amer.*, 15: 387 (April) 1935.
10. FRUEND. Experiences in prophylaxis of postoperative thrombosis and embolism. *Tag. d. deutsch. Ges. f. Chir.*, 216: 175, 1929.
11. GAMBLE, H. A. Prevention of postoperative embolism and phlebitis. *Am. Jour. Surg.*, 28: 93 (April) 1935.
12. GLAHN, A. The increase of thrombosis and embolism during years from 1919-1929. *Beitr. z. klin. Chir.*, 231: 187, 1931.
13. HENDERSON, E. F. Fatal pulmonary embolism—a statistical review. *Arch. Surg.*, 15: 231, 1927.
14. KAZDA, F. and STROCHER. The question of fatal pulmonary embolism. *Deutsch. Ztschr. f. Chir.*, 231: 187, 1931.
15. KOENIG, W. New viewpoints on origin of thrombosis. *Zentralbl. f. Chir.*, 58: 130, 1931.
16. KUGELMASS, I. NEWTON. Diet for increasing and decreasing clotting function. *Med. Clin. N. Amer.*, 19: 989 (Nov.) 1935.
17. LINDSEY, E. C. The prevention and treatment of postoperative pulmonary embolism. *Lancet*, 112: 111 (Jan. 15) 1927.
18. LOCKHART-MUMMERY, J. P. Discussion on postoperative pulmonary embolism. *Brit. Med. Jour.*, 2: 850, 1924.
19. MILLER and ROEPKE. Thrombosis and embolism. *Zentralbl. f. Chir.*, 55: 224, 1928.
20. MILLS, C. A. Relation of protein diet to thrombosis. *Ann. Surg.*, 91: 489 (April) 1930.
21. NICOLAYSEN, J. Prophylactic measures against postoperative thrombosis. *Norsk Mag. f. Laegevidensk.*, 91: 913, 1930.
22. NORDMANN. Thrombosis and embolism. *Zentralbl. f. Chir.*, 2: 913 (Oct.) 1930.
23. PATEY, D. H. Discussion on pulmonary embolism. *Proc. Roy. Soc. Med.*, 22: 729, 1929.
24. POOL, E. H. Systemic exercises—postoperative treatment. *J. A. M. A.*, 60: 1201 (Apr. 19) 1913.
25. ROWNTREE, L. G. Cardiovascular complications and their relation to surgery. *Surg. Gynec. and Obst.*, 47: 14 (July) 1928.
26. ROWNTREE, L. G. and SHINOYA, T. Studies in experimental extracorporeal thrombosis. *Jour. of Exper. Med.*, 46: 702, 1927.
27. SNELL, A. M. Relation of obesity to fatal postoperative pulmonary embolism. *Arch. Surg.*, 15: 237, 1927.
28. SHINOYA, TAKUJI, JOHNSON, W. R. and ROWNTREE, L. G. Experimental extracorporeal thrombosis. *Trans. Assn. Am. Phys.*, 42: 73, 1927.
29. WALTERS, W. A method of reducing incidence of fatal postoperative embolism. *Surg. Gynec. and Obst.*, 50: 154 (Jan.) 1930.
30. WALTERS, W. Reducing postoperative embolism. *Surg. Gynec. and Obst.*, 55: 238 (Aug.) 1927.
31. WELCH, W. H. Papers and Addresses—Baltimore, Johns Hopkins Press, 3 volumes, 1920.



# CASE REPORTS

## PREGNANCY IN RUDIMENTARY HORN OF BICORNUATE UTERUS

### SPONTANEOUS RUPTURE; OPERATION WITH RECOVERY

SANFORD KAMINESTER, M.D., F.A.C.S.

Associate Attending Obstetrician and Gynecologist, Greenpoint Hospital

BROOKLYN, NEW YORK

**P**REGNANCY in the rudimentary horn of a bicornuate uterus although not one of the rarest happenings in obstetrics is by no means common. Such a case is always of interest because of the drama associated with it and the satisfaction resulting from a successful termination.

Many women with congenital abnormalities become pregnant and abort with no complications. Often the abnormality is not recognized even then. It is a not unusual occurrence for women with these defects to go to term and have normal spontaneous deliveries.<sup>2-5</sup> Frequently, then too, the abnormality goes unrecognized. Thus Zanela<sup>1</sup> in reporting 6 cases of ruptured uterus mentions one woman who delivered her fourth child before the uterus ruptured. Another patient in this series ruptured her uterus in her fourth pregnancy with a transverse presentation. Each of these women had a bicornuate uterus with a single cervix.

The fact that one horn of such an abnormal uterus may have no connection with the other nor with the vagina is also mentioned in various textbooks.<sup>2,5</sup> Guerrant<sup>6</sup> reports from Ladin's clinic a primipara in whom rupture of a right rudimentary horn occurred when she was four months pregnant. She was operated upon and recovered. Fabris<sup>7</sup> reports a case of rupture in a rudimentary horn at three months. Sheldon,<sup>8</sup> reporting 26 cases of rupture of the uterus, describes in his Case

xxi, a patient, para v, who, at six months gestation, ruptured the left horn of a bicornuate uterus and recovered. Gordon,<sup>9</sup> reports a case in which there was fairly wide separation of the rudimentary horn from the larger one. This patient had rupture occur at the fifth month in her first pregnancy.

Although one usually associates rupture of the uterus with a patient critically ill, Kelly and Noble<sup>10</sup> state that "... in some cases of spontaneous rupture during pregnancy, the haemorrhage is so slight as to pass unobserved and the accident is discovered only when operative procedures become necessary for removal of the fetus."

The case reported here adds to the literature another case of pregnancy in a rudimentary horn of a bicornuate uterus in which external migration of the sperm occurred. This case terminated in spontaneous rupture, at five and one-half months followed by operation and recovery.

R. D., aged twenty-four years, was admitted to the Greenpoint Hospital, November 5, 1936. She had been married for a year and a half and had had her last menstrual period on April 18, 1936, five and a half months previous to admission. This was her first pregnancy.

The pregnancy had been normal except for moderate pain in the lower abdomen in August and October, 1936. This pain had been sharp enough to limit the patient's activity but not to incapacitate her. At four o'clock on the morning of admission, the patient experienced severe

pain in the epigastrium and in the region of the umbilicus. A physician was called but could feel no labor pains. He listened for and heard

visible nor palpable. The fetal heart is not audible. The fetal parts are easily palpable; no uterine contractions are made out. In either

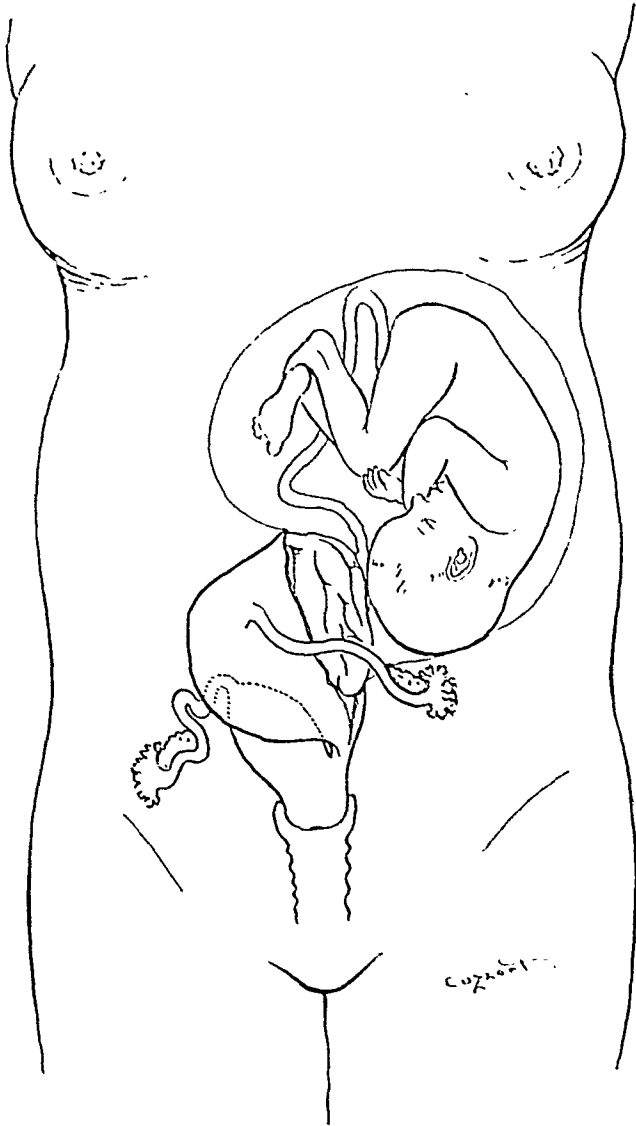


FIG. 1. Schematic representation of findings at operation.

the fetal heart and administered morphine sulphate grain  $\frac{1}{4}$  to relieve the pain, following which the patient vomited. At nine A.M. a second, more severe attack occurred, accompanied by vertigo and faintness.

On admission to the hospital at eleven A.M., the following observations were made.

"The patient is a well nourished, well developed young adult female, acutely ill. She is in shock. Her pulse is 140 beats per minute, her blood pressure is 48/25. The skin is pale, lips cyanotic. There is a cold perspiration on her face. The heart tones are distant. The abdomen is distended, a swelling reaching from the symphysis to a point halfway between the navel and the ensiform. No fetal movement is

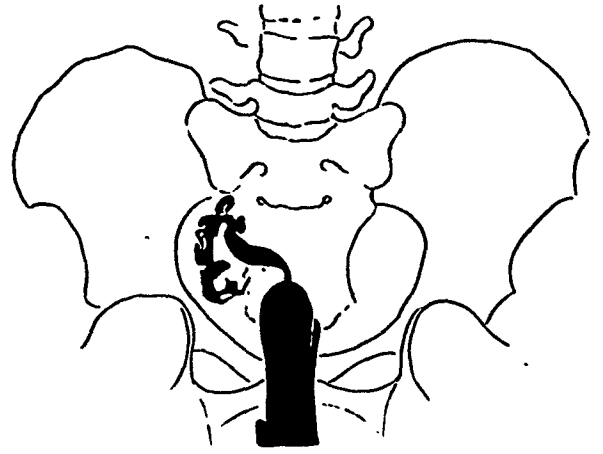


FIG. 2. X-ray picture following lipiodal injection.

lower quadrant, there is exquisite tenderness with marked rebound tenderness. No masses are felt but there is marked tenderness in either vaginal vault."

Morphine sulphate grain  $\frac{1}{4}$  was administered and a solution of 5 per cent glucose was given by hypodermoclysis. The patient was placed in Trendelenburg position. The blood pressure readings were taken at fifteen minute intervals; by five P.M. it had risen to 90/60, and the pulse rate was 130. Since there was no further improvement 500 c.c. of blood was given by indirect transfusion and the patient's abdomen was opened.

A large quantity of free blood and blood clots were found. The omentum reached into the pelvis. Behind it an amniotic sac containing a dead fetus (Fig. 1) was found. This sac was ruptured and the fetus was delivered. It was then discovered that the placenta was protruding from a rent in the posterior wall of the left horn of a bicornuate uterus. This uterus measured 10 cm. in diameter. Attached to it were the left tube and ovary. A very definite band of constriction separated this structure from the right horn. It was easy to apply two clamps across this band and remove the left horn.

Following operation, a second transfusion of 250 c.c. of blood was administered. Except for a moderate morbidity and some separation of the wound edges, the patient made an uneventful recovery and left the hospital on the eighteenth day after operation.

When the specimen was examined, one was unable to make out a canal at the site of transection. Numerous blocks were cut from this region for microscopic study but none of them revealed anything resembling an endometrium.

Two months after operation, the patient was seen again. The abdominal wound was healed. Lipiodol was injected into the cervix and an x-ray picture was taken which showed one uterus and one patent tube (Fig. 2). It failed to give any suggestion of a remnant of a left uterine horn.

#### DISCUSSION

Although the failure to find a canal at the site of transection of a rudimentary left cornu is not conclusive evidence of its absence, two other findings point to this conclusion. One is the fact that a band of tissue separated the left cornu from the rest of the uterus and the other, is the absence of any evidence of even a minute canal going toward the left side of the retained uterus in Figure 2. We must therefore deduce that we are dealing with another case of "wandering fertilized ovum"<sup>11</sup> or transperitoneal migration of the sperm.

#### SUMMARY

A case is reported of a twenty-four year old primigravida in whom spontaneous

rupture of a rudimentary uterine horn occurred after five and one-half months amenorrhea. The ruptured horn and dead fetus were removed at laparotomy. The patient recovered. Two months later an x-ray picture taken following transuterine injection of lipiodol showed the remaining horn and tube of a bicornuate uterus.

#### REFERENCES

1. ZANELA, S. Uterus Bicornis in Geburtschilfe. *Zentralbl. f. Gynäk.*, 59: 1879-1889 (Aug.) 1935.
2. BECK, A. C. *Obstetrical Practice*. Baltimore, Williams and Wilkins, 1935, p. 496.
3. BETTMAN, M. A case of Labor in a Bicornuate Uterus. *Johns Hopkins Hospital Bulletin*, 13: 56, 1902.
4. MILLER, N. F. Clinical Aspects of Uterus Didelphys. *Am. J. Obs. and Gyn.*, 4: 398, 1922.
5. DELEE, J. B. *Principles and Practice of Obstetrics*. Phila., W. B. Saunders Co. Ed. 4, 1924, p. 545.
6. LADIN, L. J. Pregnancy in Rudimentary Horn of Uterus. Operation with Recovery. *S. Clin. N. Am.*, 15: 537-543 (Apr.) 1935.
7. FABRIS, M. *Ann. di. Ostet. e. Ginec.*, 57: 1023-1028 (July) 1935.
8. SHELDON, C. P. Record of 26 Cases of Rupture of Uterus. *Am. J. Obs. and Gyn.*, 31: 455-466 (March) 1936.
9. GORDON, C. A. *Am. J. Obs. and Gyn.*, 29: 279 (Feb.) 1935.
10. KELLY and NOBLE. *Gyn. and Abd. Surgery*. Vol. 2, Phila., W. B. Saunders Co., 1907, p. 106.
11. GRAVES. *Gynecology*. Ed. 3., Phila., W. B. Saunders Co., 1926, p. 478.



# EPIGASTRIC HERNIA CAUSING SEVERE SYMPTOMS\*

M. R. CHARLTON, M.D., F.A.C.S.

TILLAMOOK, OREGON

TEXTBOOKS on surgery as a rule discuss epigastric hernia rather briefly and inadequately. They all state, however, that the condition is a cause of various symptoms which may be confused with those of intra-abdominal disease. From time to time, we need to be reminded of such obvious facts in cases seen rather infrequently by the general practitioner. This particular point was recently emphasized for me by the following case.

J. S., aged sixty years, male, came to the hospital April 11, 1936 complaining of severe abdominal pain.

*Past History.* When sixteen years old he was operated on for harelip. While taking the anesthetic he began to vomit and was struck across the abdomen by one of the doctors to start him breathing. Patient dates his stomach trouble of long standing from this occurrence. He began to have attacks of stomach ache after this, lasting for a day or two. These spells occurred from a week to a year apart, but gradually increased in frequency and severity. In the interim he suffered constantly from indigestion. He has had much treatment but no surgery. Eight years ago he spent three months in a hospital in Tacoma under treatment for ulcer with very little benefit. He had typhoid fever at twenty-four years, but no other serious illness. He has had no acute attacks of pain for three years preceeding the present illness but has been on a diet constantly for indigestion.

*Present Illness.* March 20 at 3 P.M. he suffered a severe abrupt attack of pain in the pit of the stomach. He had eaten a meal of meat loaf in a restaurant a half hour previously. This was a departure from his customary diet and was attributed by the patient as the cause of the attack. After the pain started he vomited and was partially relieved but the pain has continued intermittently since. He has vomited daily, sometimes five times. He has been on a milk diet.

*Examination* showed a robust well preserved male, 6 feet tall, weighing 190 lbs. evidently in

extreme pain and appeared in mild shock. There is evidence of a repaired hare lip and complete cleft palate. His temperature was 100.4; the pulse rate 104, slightly irregular; blood pressure 110/70. The physical examination was negative except for the abdomen.

There was no distention or rigidity, except that pressure in the epigastrium provoked resistance. There was a palpable boggy mass in the lower left quadrant, probably feces and a 5 cm. soft tender, irreducible tumor just above the umbilicus. No opening in the fascia could be felt.

The patient's appearance on admission was such that a ruptured peptic ulcer was considered, but as this did not square with the physical findings a policy of watchful waiting was followed, and the acute pain gradually subsided somewhat. The urine and blood were normal and the Kahn test was negative. X-ray examination showed normal contours with increased peristalsis.

On April 15, under avertin and procaine, an incision was made over the linea alba. The tumor proved to be a fatty mass larger than it appeared from palpation and flattened out about 7 cm. in diameter. There was a circular opening through the fascia about 2 cm. in diameter through which omentum protruded. The sac could not be distinguished except at the edges of the opening. Exploration of the abdomen revealed no pathology except that the vessels of the stomach appeared engorged. The mass, continuous with omentum was excised, the peritoneum adherent to the ring separated and closed, and the opening in the fascia overlapped laterally.

On the day following the operation the patient had a profuse bloody emesis and considerable pain for four days. Following this the convalescence was uneventful and he was dismissed on the eighteenth postoperative day. Up to this time he has been entirely relieved of his symptoms.

An epigastric hernia is formed, according to Quain<sup>1</sup> by a small tag of preperitoneal fat or the fat in the fold of the hepato-umbilical ligament forcing itself

\* From the Surgical Service of the Charlton Hospital.

through the transversalis and rectus fascia at the site of the opening for a blood vessel. These most often occur in the linea alba. Most of these hernias remain quite small, are not hernias of the abdominal contents and do not involve the peritoneum. Small hernias elsewhere are often difficult to detect by palpation from without. Paradoxically the small epigastric hernias can not be detected by palpation from within. This point must be kept in mind in exploration. A certain percentage, not more than 1 in 20 according to Moschcowitz,<sup>2</sup> continue to enlarge until the opening in the fascia permits intra-abdominal pressure to force the peritoneum through it followed by abdominal contents, usually omentum.

One would naturally expect these larger hernias with formed sacs to cause the more severe symptoms. However, this does not appear to be the case. Quain<sup>1</sup> states that epigastric hernias with well formed sacs cause no more symptoms than smaller ones; Sullivan and Antupit,<sup>3</sup> that it is the small hernias the size of a pea, that cause the most symptoms of abdominal disease.

The symptoms and signs of epigastric hernia may quite properly be divided into two groups: (1) those local symptoms directly associated with the hernia, namely tumor, tenderness at the site of the opening, local and superficial, due to preperitoneal fat caught in the ring and often relieved by recumbency; and (2) symptoms not directly associated with the hernia and simulating such a variety of conditions as gastric cancer, peptic ulcer, gall-bladder disease, chronic appendicitis, and intercostal neuralgia.

While most surgeons seem to accept this latter class of symptoms as sometimes being caused by epigastric hernia the opinion is by no means unanimous. Lewisohn<sup>4</sup> does not believe that simple epigastric hernia causes serious gastrointestinal symptoms. He observed 13 cases over a period of three years in which the repair of such a hernia did not relieve symptoms. Eleven of these cases proved to have lesions in the stomach of duodenum. He also emphasizes the frequency of co-existing disease with epigastric hernia.

Moschcowitz<sup>2</sup> believes epigastric hernia is responsible for intra-abdominal symptoms in only a small percentage of cases; Gilbride,<sup>5</sup> that the hernia does not cause symptoms simulating intra-abdominal disease and that these are due to associated conditions.

On the other hand, Friedenwald and Morrison<sup>6</sup> in a comprehensive review report 65 cases causing symptoms in their experience. Eleven of these were confused with chronic appendicitis, 7 with gall-bladder disease, 7 with duodenal ulcer, and 3 with cancer of the stomach. Most of these cases were entirely relieved by repair of the hernia. They state that many patients who have been treated for years for ulcer, gastritis, nervous dyspepsia, and gallstones, are cured by repair of the hernia.

I believe that in the course of routine physical examinations these small hernias are discovered not at all infrequently and that they seldom cause any severe symptoms. With no records to support it, my personal belief is that it is only the hernia involving intra-abdominal contents that causes intra-abdominal symptoms.

#### SUMMARY

1. One case of epigastric hernia involving abdominal contents is reported which was apparently responsible for severe symptoms of intra-abdominal disease.

2. It is still a controversial matter whether or not simple epigastric hernia simulates intra-abdominal disease.

3. In exploratory procedures epigastric hernia should be kept in mind when intra-abdominal disease is expected, and vice versa; also the possibility of the two conditions co-existing. Further, the anatomical considerations making small hernia not evident from within the abdomen are to be considered.

#### REFERENCES

1. QUAIN. *Jour. Minn. Med. Assn.* (July), 1910.
2. MOSCHCOWITZ. *Ann. Surg.*, 66: 300, 1917.
3. SULLIVAN and ANTUPIT. *Ann. Surg.*, 86: 413, 1927.
4. LEWISOHN. *Surg., Gynec. and Obst.*, 32: 546-551, 1921.
5. GILBRIDE. *J. A. M. A.*, 87: 1470, 1926.
6. FRIEDENWALD and MORRISON. *J. A. M. A.*, 87: 1466, 1926.

# VOLVULUS OF RIGHT COLON AND MECKEL'S DIVERTICULUM\*

ADOLPH A. WALKLING, M.D.

Assistant Professor of Surgery, Jefferson Medical College; Assistant Surgeon, Pennsylvania and Jefferson Medical College Hospitals

PHILADELPHIA

**V**OLVULUS of the right colon is less common than volvulus involving the left colon. This is due, of course, to the fixation of the right colon. There is almost invariably a congenital abnormality present in order that volvulus of the right colon can occur.

Insufficient intestinal fixation is by far the most frequent cause of obstructive symptoms due to anomalies of intestinal rotation and the most frequent form of obstruction is volvulus.

O. J., male, white, ten years old, was admitted to Medical Service B. Jefferson Hospital, November 18, 1929, complaining of pain across the abdomen and vomiting.

There were five brothers and sisters, all living and well.

*Past History.* He weighed four pounds at birth and was "difficult to raise." He had many illnesses. Five years ago, he had what was thought to be appendicitis, but was not operated upon. Every few months, for the last five years he has been subject to attacks of cramp-like and intermittent pain in the abdomen referred to the navel which lasted forty-eight hours, and was associated with vomiting every fifteen or twenty minutes. During the interval he was perfectly well. He has always been constipated and used laxatives or enemas continually.

*Present Illness.* At 2 A.M., November 17 he was awakened with severe cramp-like pains in the abdomen and vomiting. The vomiting continued until 6 A.M. Wretching continued thereafter until admission at 5 P.M. November 18. The symptoms subsided suddenly and he was perfectly well during the remainder of his stay in the hospital.

*Laboratory Studies.* Blood count, gastric analysis, gall-bladder drainage, stool and urine examinations were normal.

*X-ray Studies.* November 21, 1929. No evidence of organic disease. There was some gastric retention but no cause could be found. The cecum freely movable and was not tender.

*Diagnosis.* Gastropasm. Cholecystogram and flat plate of abdomen negative.

*Physical Examination.* A well nourished young white boy, with no abnormal findings. The abdomen was flat; no masses were palpated but there was tenderness on deep pressure at the navel and in both flanks.

He was discharged November 27, 1929, with the diagnosis of gastropasm.

August 24, 1931 he was readmitted with the same complaints and after two days in the hospital the father took the child home after refusing operation. It was thought that there was a Meckel's diverticulum present. No x-ray studies were made at this time.

He was again readmitted March 14, 1933. Since his release from the hospital August 26, 1931, he has had his usual attacks of pain and vomiting but has always been relieved in a few hours by rest in bed and hot water bottles. At 4 P.M., March 13, 1933, an attack began suddenly while at school. The vomiting continued for two hours. The pain increased in severity and about 7 P.M. the right side of the abdomen was becoming distended. He was driven forty miles in an automobile to the hospital.

*Physical Examination.* The patient was lying on his back with his knees drawn up and having spasmodic attacks of abdominal pain. The head and chest were negative.

The abdominal wall was tense, and the abdomen distended asymmetrically, mostly in the right. There a cystic, tender mass occupied the whole right side of the abdomen and appeared to be distended bowel. Diagnosis of volvulus was made and the patient operated upon.

*Operation.* March 14, 1933, ether anesthesia.

\* Read before the Philadelphia Academy of Surgery, December 2, 1935.

On opening the abdomen through a right paramedian incision, a large quantity of dark brown fluid escaped. A large, cystic, black



FIG. 1. Specimen removed at operation.

mass presented itself and was found to be cecum, ascending colon and ileum. There was a Meckel's diverticulum attached to the umbilicus by a cord. The cecum, ascending colon and distal ileum were rotated over from right to left making one complete turn. The whole mass then was found to be across the cord from Meckel's diverticulum. This cord was cut and the mass delivered. The vessels were thrombosed and the intestinal wall gangrenous. The ileum proximal to the diverticulum was cut across between Payr clamps. The cecum and ascending colon were attached by a very long mesentery and the axial center of rotation was the proximal transverse colon. The transverse colon proximal to the midcolic artery was cut between clamps and the mass removed. A side-to-side anastomosis was made between the ileum and transverse colon using the Kerr technique. The edges of the mesentery were brought together and the abdomen closed with a drain in the pelvis.

*Progress.* The patient was treated with intravenous glucose and saline by hypodermoc-

clysis and duodenal tube. There was marked distention. On the seventh day he had several copious dark watery bowel movements. Thereafter his convalescence was uneventful but for a slight infection of his wound. He was discharged the thirty-fifth day as well.

A third readmission was on November 9, 1934. The patient had been perfectly well since the previous operation. He had had none of the digestive disturbances that he had previously and has not had to use laxatives. That day, after lunch he had a sharp pain in the abdomen with vomiting. The pain was spasmodic and severe. One enema was effectual at 2 P.M. but he had passed no gas or feces since. The pain has continued.

*Examination.* The abdomen was distended, tense and tender; peristalsis was hyperactive.

*Diagnosis.* Obstruction.

*Operation.* A low midline incision was made. Distended ileum was found in lower abdomen. A band of adhesions had anchored the ileum to part of the scar of the previously excised mesentery of the ascending colon. This was cut and ligated. There were no other adhesions in the abdomen. The site of the anastomosis done six months ago was satisfactory and the stoma was probably  $1\frac{1}{2}$  inches long. The abdomen was closed without drainage.

Recovery was uneventful.

He has been seen several times since his last operation and has had no further trouble.

Rotation of the intestinal tract occurs in three stages. The first step takes place between the fifth and tenth week while the loop of midgut lies in the umbilical cord. The second stage is characterized by the further elongation and finally a return to the abdominal cavity of the whole intestinal canal. Fixation is maintained by the vitelline duct and the vitelline artery which is the termination of the superior mesenteric artery. The cecum is caused to descend to the right loin by further elongation of the colon. This is complete about the eleventh week. The term "non-rotation" refers to a failure in the second stage. The third stage is characterized by the further descent of the cecum and fixation of certain portions of the intestine to the posterior abdominal wall by fusion of their mesenteries with the posterior parietal

peritoneum. The third stage is complete usually about the first month.

The predisposing causes of volvulus are (1) an unduly narrow loop or group of loops of intestine, (2) undue length of mesentery, and (3) a point of adhesion at the convexity of the loop, which can act as an axis of rotation. The exciting causes are (1) unusual effort or accidental movement of the body, (2) the peristaltic motility of the intestine, and (3) undue distention of the intestine. In this instance we have two factors to consider as the cause of volvulus; (1) an elongated mesentery or a failure fixation of the cecum and ascending colon and (2) fixation of the convexity of the loop by the remains of the vitelline duct.

The volvulus occurred in this instance by a rotation of the cecum, ascending and proximal transverse colons and the terminal ileum on its mesenteric attachment. The mass then folded over the remains of the vitelline duct.

#### SUMMARY

A case of volvulus of Meckel's diverticulum is reported, illustrating the fact that gastrointestinal symptoms in growing children may be the result of certain congenital anomalies which may require rather radical surgery. Congenital anomalies of the right colon are probably more common than previously supposed. This patient had three anomalies which produced symptoms.



WHEN it [fecal impaction] is situated beyond the reach of the finger, or if of too firm a consistency to be easily manipulated, inject 8 or 10 fluid ounces of warm mineral oil, olive oil, or cottonseed oil, with the patient in the knee-shoulder position. Allow this to remain for 12 hours, and it will so soften and disintegrate the mass that it can be usually passed without any difficulty.

From—"Synopsis of Ano-Rectal Diseases" by Louis J. Hirschman, M.D.



# ACUTE REGIONAL (TERMINAL) ILEITIS

THOMAS J. RYAN, M.D.

PHILADELPHIA

**T**ERMINAL ileitis is described as a chronic and nonspecific granulomatous disease. It has been suggested by Crohn that an acute stage exists. The purpose of this case report is to record an instance of acute terminal ileitis and to review the suggested forms of treatment.

Lee and Bockus,<sup>1</sup> state that it is possible that the chronic form of this disease may result from an acute stage, and refer to the case reported by DeCourcy<sup>2</sup> in which an operation upon a girl twenty years of age revealed marked inflammation of the terminal twelve inches of ileum. The inflamed bowel was returned to the abdomen and the patient made a complete recovery after a very stormy convalescence.

Mixer<sup>3</sup> quotes the grouping of regional ileitis suggested by Crohn:

*Group 1.* This group shows signs of acute intra-abdominal inflammation, indistinguishable preoperatively from acute appendicitis. There are pain and tenderness in the right lower quadrant, cramps, fever and leucocytosis. A mass may be palpable. At operation the terminal ileum is reddened, greatly thickened and bleeds readily, and its mesentery is edematous and contains enlarged hyperplastic lymph nodes. The appendix may be reddened and involved by contiguity but it shows no mucosal inflammation.

*Group 2.* The second stage presents symptoms suggestive of ulcerative colitis. There is colicky abdominal pain and looseness of the bowels, at times with blood and mucus. There is slight fever, malaise, marked loss of weight, and anemia, often severe, develops.

*Group 3.* The stenotic stage follows the ulcerative phase. Due to the extreme thickening of the bowel wall the lumen of the bowel becomes constricted and may be partially obliterated by the healing of the mucosal ulcerations. Usually the narrowing is most evident near the ileocecal valve, while above, in the more recently involved portion of the bowel, the earlier ulcerative phase predominates. The symptoms are those of partial obstruction of the small intestine. In this stage a mass is usually felt.

*Group 4.* The stage of fistula formation. This is a late manifestation of the disease and is the result of slow perforation of the ulcers. Frequently multiple fistulas are formed which may open externally through the abdominal wall or may be internal and at times can be demonstrated by roentgenologic examination of the gastrointestinal tract. In contradistinction to appendiceal fistulas which tend to heal, such fistulas are persistent and resist operative attempts at closure.

Mixer stated that

they have operated upon only one case that might have been placed in the early phase of the process. In this case an immediate resection and anastomosis were performed with prompt recovery. The question may well be raised whether or not a procedure of this magnitude was indicated in the early stage of the disease and whether a temporary ileostomy or ileocolostomy might not have sufficed. In answer it can be said that the disease tends to progress, and where graded procedures have been employed we have generally found that the involved segment of bowel has later developed some form of complication, whether abscess or fistula, that has rendered resection much more difficult and hazardous.

In discussing Mixer's paper Dr. Emmet Rixford referred to an acute case that came

<sup>1</sup> LEE and BOCKUS. *Ann. Surg.*, 102: 412-421 (Sept.) 1935.

<sup>2</sup> DECOURCY. *Jour. Med.*, 15: 216, 1934.

<sup>3</sup> MIXER, C. G. *Ann. Surg.*, 102: 674-694 (Oct.) 1935.

under his care eight years previous, in which the lower third of the ileum was swollen, red, and covered with an exudate. The appendix was removed but no operation was performed upon the ileum. Prompt recovery occurred with no recurring symptoms to date.

M. Q., a female aged eight years, was admitted to the Misericordia Hospital on March 17, 1936 with a temperature of 99 degrees, pulse rate 90, and respiratory rate 24. Urine examination was negative; hemoglobin 74 per cent, erythrocytes 4,370,000 and leucocytes 31,000.

The chief complaint was abdominal pain associated with vomiting. Four days prior to admission the patient developed headache, nausea and vomiting. On the day previous to admission abdominal pain developed which was most marked in the right lower quadrant.

General physical examination was negative except for rigidity over the lower abdomen, particularly on the right side. The father died of tuberculosis at thirty-three years of age, after having been confined to a sanitarium nine months prior to his death. There are four other children in the family, all well. The mother is in good health. With the exception of measles and whooping cough four years ago there are no other important items in the family history.

A diagnosis of acute appendicitis was made and operation was performed on the day of admission. Upon opening the peritoneal cavity an excessive amount of peritoneal fluid was present, and an extensive inflammatory process involving the terminal portion of the ileum. The bowel wall was covered with a thick layer of fibrin which was removed and sent to the laboratory for examination. Three small areas, measuring  $\frac{3}{4}$  inch in diameter, were darker than the major portion of the bowel, and appeared to be early areas of gangrene. The thickness of the bowel wall was very definite and extended from the ileocecal valve for a distance of about 8 inches. The edema gradually subsided to normal bowel. There was no evidence whatever of any inflammatory reaction in the cecum. The mesenteric lymph nodes were enlarged but there was no pathology in the mesentery which would suggest mesenteric thrombosis. There was no evidence which might

suggest that the pathology in the bowel was the result of a relieved intussusception. Cultures were made but no organisms were found. A first stage Mickulicz resection was performed and the abdominal cavity closed around the exteriorized bowel.

On the third postoperative day the areas of discoloration had increased in size and it was thought advisable to resect the loop of intestine. Blood culture was negative. The patient died on the fourth postoperative day.

Autopsy revealed that the patient died from a generalized peritonitis which was apparently primary inasmuch as there was no evidence of leakage at the operative site. The lungs showed evidence of a healed tuberculous nodule in the left lower lobe associated with pleural adhesions. The mesentery showed no evidence of vascular occlusion. The nodes were hyperplastic. The pathological report on the appendix was acute periappendicitis. Microscopic examination of the fibrin revealed nothing definite. A similar examination of the resected ileum revealed the following:

#### PATHOLOGICAL REPORT

*Gross Description.* Specimen consists of 12 inches of resected ileum of normal calibre. The wall is uniformly thickened and edematous except the proximal 2 cm. which is normal in thickness. The serosa is covered with a thin layer of fibrin and the bowel presents a dusky appearance with scattered irregular black areas. The mucosa is smooth, thickened, velvety; it presents no definite ulcerations but has a variegated color with scattered petechial and small gangrene areas. The bowel is cut close and no mesentery is submitted with the specimen. The blackish areas of gangrene are more numerous near the mesenteric attachment.

*Microscopic examination of three sections from the thickened portion of resected ileum.* The serous surface is covered with a thick layer of fibrin. All layers of the bowel wall are involved in an acute diffuse suppurative inflammatory process, are edematous, show scattered areas of hemorrhage and much cellular exudation with polymorphonuclear leucocytes predominating. The mucosa shows partial degeneration and there are no areas of ulceration.

*Diagnosis.* Acute diffuse suppurative inflammation of ileum.

## COMMENT

At the time of operation it appeared that an extensive resection of the ileum would result in a fatal outcome. For this reason the cecum and inflamed portion of the ileum were brought out of the abdomen and the peritoneum carefully sutured around the bowel. The procedure was not justified by the result.

In personal communications from Dr. Mixer and Dr. Crohn they suggested that

an ileocolostomy, combined with resection, would probably be the best procedure to follow in this disease. Although this extensive resection appears hazardous in the presence of such acute inflammation the recoveries reported justify the procedure. The case reports of DeCourcy and Rixford show that recovery will occur without resection. Only through accumulated statistics will it be possible to finally determine the best method to follow.



THE Preparation of Suitable Maggots. (a) The securing of a suitable variety of fly. (b) The constant production of large quantities of eggs. (c) The sterilization of the maggots.

The last is the crucial difficulty, and requires the activities of a skilled entomologist plus pathologist.

From—"Recent Advances in Orthopaedic Surgery" by B. H. Bruns, F.R.C.S. and J. H. Ellis, F.R.C.S.

# STUDIES OF THE NATURAL HISTORY OF GENITOURINARY TUMORS. I: PRIMARY CANCER OF URETER

## AUTOPSY STUDY WITH REVIEW OF THE LITERATURE

JUDSON B. GILBERT, M.D.

SCHENECTADY, N. Y.

THE purpose of this study is to add an autopsy report of primary cancer of the ureter to the 40 previously published cases. Twenty of these reports show that no operative intervention was attempted and that the majority of the others had exploratory operations only. From this data the natural history processes of this disease can be estimated. This study has been directed particularly to the duration of symptoms previous to observation and the total length of life following diagnosis or operation. Since only reports of unquestioned primary malignant tumors have been accepted a composite study of the metastases and their extension has also been made.

A full abstract of these accepted cases is not presented as recently several complete reviews have been published. Points of unusual interest are recorded and the accepted cases are arranged alphabetically and chronologically in the bibliography.

### CASE REPORT

M. S., a sixty-eight year old, single, Russian laborer was admitted to Bellevue Hospital, with a chief complaint of pain in the epigastrium. The family and past histories were irrelevant.

For two years the patient complained of dull epigastric pain which radiated downward over the entire abdomen, with indefinite relationship to meals. Vomiting after meals, diarrhea and bloody stools, anorexia, a slightly productive cough and dyspnea had all persisted for one month. Precordial pain had been present for three days. He complained of nocturia five to six times for a month, and had lost 60 pounds in weight.

Physical examination revealed an elderly, markedly emaciated, dehydrated and dyspneic

man. The abdomen was slightly distended. The liver and spleen were palpable but not enlarged. The kidneys were not palpated. There were enlarged inguinal lymph nodes. His blood pressure was 98 systolic and 84 diastolic.

*Laboratory Reports.* Urinalysis showed specific gravity 1.010; alkaline reaction; trace of albumin; a few epithelial cells but no pus or red blood cells were reported. Blood count: leucocytes 8200; polymorphonuclears 78, lymphocytes 20, and transitional cells 2 per cent; erythrocytes 5,490,000; hemoglobin 70 per cent.

A provisional diagnosis of carcinoma of the stomach was made. The patient died the following day before further studies could be accomplished.

*Autopsy.* An emaciated white male measuring 5 feet, 10 inches and weighing about 150 pounds. No abnormal changes referable to nose, mouth, eyes or ears were found, nor edema, jaundice or enlargement of the superficial lymph glands. The distribution of the hair was normal. The external genitalia appeared normal but the genitourinary organs were of most interest and are described in detail.

The right kidney weighed 140 grams, appeared to be of normal size and was of reddish color. The capsule stripped easily leaving a smooth surface. There were no hemorrhages. On section, the normal markings of the kidney were easily distinguished. The right ureter appeared normal. The left kidney was increased in size and appeared lobulated. The kidney was bluish-red and on section consisted of numerous well separated cystic areas. The parenchyma of the kidney was reduced to a shell and a greenish-yellow exudate was present in the pelvis of the kidney. The ureter and the pelvis were markedly dilated, the ureter being dilated in its entirety. About 8 cm. from its entrance into the bladder there was a thickening of the ureteral wall

consisting of firm, white tissue, with encroachment upon the lumen by this growth. The bladder was of normal size with a slightly

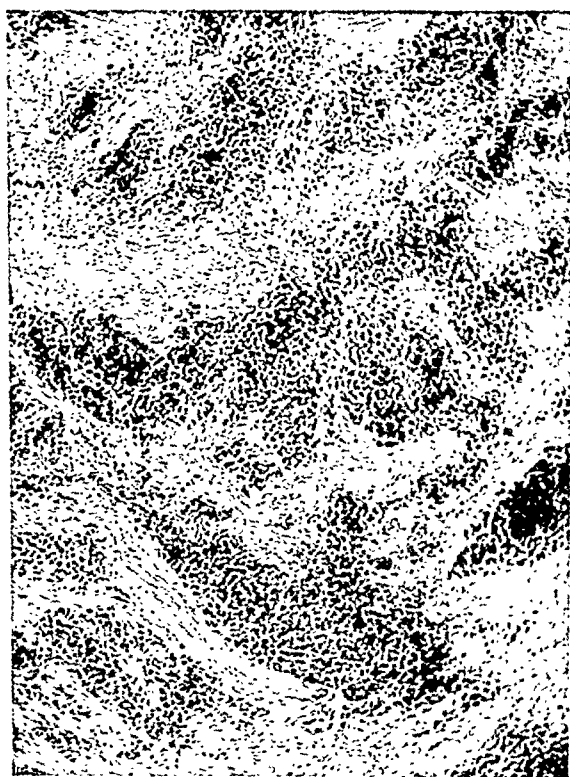


FIG. 1. Low power of diffusely growing epithelioma of the ureter, grade II.

thickened wall. Close to the bladder neck the mucous membrane appeared hypertrophied and there was a region of bluish-black discoloration covered by an area of thick, yellowish exudate. The prostate was increased in size and cut with increased resistance, but appeared normal on section. There was no evidence of local extension or metastases in the other abdominal or thoracic organs.

*Summary of Anatomical Diagnosis.* Carcinoma of the lower third of the left ureter with dilatation; hydronephrosis of the left kidney; cystitis; prostatic hypertrophy; bronchopneumonia; arteriosclerosis of the aorta; fatty degeneration of the liver, and general emaciation.

*Microscopic examination* of the primary ureteral tumor showed a background of fibromuscular tissue scattered through which were innumerable islands of tumor cells. The latter, for the greater part, showed large rounded or oval, rather richly chromatic nuclei embedded in a scanty smooth pinkish staining cytoplasm. Among them were a few very large flattened cells with richly chromatic, sometimes lobu-

lated nuclei resting in relatively very large amounts of smooth, bright pinkish staining cytoplasm. The whole represented the remains of cells of the squamous type. The tumor is a diffusely growing epithelioma.

*Incidence.* The observation here reported is the only instance of proved primary ureteral cancer in the 22,810 autopsy files of Bellevue Hospital from 1904-1935. The clinical files of the urological service of Bellevue Hospital show no records of this rare disease; Pack and Le Fevre in 1930 disclosed no cases observed at the Memorial Hospital of New York, in their study of 16,565 malignant tumors.

*Age Period.* There were no children or young adults in this series. Zironi's and Scott's reports are the only records of the fourth decade, both patients being thirty-six years of age. The oldest case reported by Richter, was an eighty year old woman. There were 11 cases in the fifth, 10 each in the sixth and the seventh and 6 cases in the eighth decades. The mean age for the entire series was fifty-eight years while the average age was fifty-seven years.

*Sex and Color.* There were 24 males and 17 females in this series. Rousselot and Lamon reported the only tumor present in a Negro.

*Previous Duration of Symptoms Related to Ureteral Cancer.* In 7 cases this data is either missing or indefinite; in the remaining 34 cases the average duration prior to diagnosis or operation was fifteen and one-half months. If the cases of Israel and Loewenstein, where the history recorded symptoms for ten years, and the recent report of Cochems and Grauer with a duration of fifteen years are excluded, then we find a period of seven months as the average duration prior to diagnosis or operation.

Israel and Loewenstein in 1911 reported a right sided ureterocele coincident with cancer of the left ureter; the presence of this ureterocele suggests urinary tract pathology of probably long duration. A recent report of my own with combined bilateral ureterocele, ureteritis cystica, and

primary cancer of the right ureter also gave a seven year history of urinary symptoms. Cochems and Grauer's patient, a fifty-one year old woman, complained of aching pain across the right abdomen and the right lumbar region for fifteen years. No hematuria was noted but the right kidney was palpable. The primary cancer, located in the middle third of the right ureter was found associated with leucoplakia and a small calculus. Here again the long duration of symptoms suggests the presence of previous benign ureteral obstruction with subsequent hydronephrosis.

*Symptomatology.* Pain was the principal symptom which brought the patient for examination, as recorded in 33 cases. In 6 cases the pain was predominantly in the back, and in the cases of Spiess, Schmitt and Glas the provisional diagnosis of "sciatica" was made. Hematuria was noted 21 times. Volante's patient had noted gross bleeding eleven years previously. In 28 instances a palpable tumor mass was noted on examination, which usually proved to be a hydronephrotic kidney above the ureteral obstruction. The primary ureteral tumors per se were not bulky in cross section, although the entire ureter may be involved.

*Cystoscopy and Roentgenographic Examination.* Cystoscopic examination was performed 22 times and in 16 cases aided directly in establishing the correct diagnosis. The roentgenogram assisted in the diagnosis of associated calculi in 5 of 6 cases. Davy in 1884 found the calculus at autopsy; however, he performed cystoscopy but was unable to obtain urine from the left ureter which later proved to be the seat of primary cancer. Sommer in 1932 was confused by the presence of a calcified ovary which existed on the same side as the primary tumor. Severe hemorrhage followed manipulation in Scott's and Hunter's cases which directly aided in the correct diagnosis.

*Diagnosis.* In 9 reports a correct clinical diagnosis was made before operation or autopsy. The diagnosis of malignancy was

made in the following cases: Ureteral tumor, eight times; osteosarcoma of the pelvis, twice; kidney tumor, twice; bladder tumor, twice; kidney pelvis tumor, once; and cancer of the stomach, once.

The 2 cases of Hektoen and Butler suspected of being primary sarcoma of the pelvis later proved to be tumors of the lower third of the ureter, both on the right side, with secondary extension to the bony structures. Our own case was in extremis and the provisional diagnosis of cancer of the stomach was made from the history of predominantly gastrointestinal symptoms. This symptom complex is commonly confusing in the presence of obstruction to the upper urinary tract.

*Operative Procedure.* Surgical removal was not attempted in 20 instances, due either to inability to make a correct diagnosis or the extremely poor condition of the patient on admission. Nephrectomy only was done by Gerstein. Nephrectomy and ureterectomy was done five times, while nephrectomy and splenectomy was done by Israel. Partial low ureterectomy only was performed in Snyder and Wood's case because the condition of the patient prohibited further procedures. Hunter performed partial ureterectomy without nephrectomy and successfully removed the entire tumor. Subsequent death was due to a colloid carcinoma of the stomach six years later. Exploratory kidney operations were done six times. Exploratory laparotomy, cystotomy, bladder cauterization and prostatectomy were performed once each. In 2 cases, bladder tumors were considered as extensions of the primary ureteral cancer. In the light of newer interpretation these tumors should be considered as the extensive or diffuse simultaneous appearance of the same process and not a metastasis or implantation.

*Pathology.* Side Involved. The seat of the primary tumor was located 17 times on the right and 24 times on the left side. The right ureter was involved twice in the upper third, 6 times in the middle, and 16 times in the lower third. The left ureter

showed lesions twice in the upper third, twice in the middle and 13 times in the lower third. The middle and lower thirds were involved in one extensive tumor twice on the right and once on the left side. Ureteral anomalies were not common. Jona reported a papillary tumor present in a diverticulum of the lower third of the left ureter about 1.5 cm. in diameter.

*Local Extension and Metastases.* In the 2 cases of Jona and in the case of Ascoli the tumor was limited entirely to the ureter without local extension or metastases. In 13 instances there were no local extensions while in 20 cases there were localized periureteral infiltrations. The bladder was involved five times while the seminal vesicle and the dorsal vertebrae were each involved once.

*Metastases.* There were no metastases present in 11 autopsies. The retroperitoneal lymph glands were involved 12 times; the liver 9 times; the lungs 8 times; the kidneys 5 times; while spleen and bones were affected 3 times each, (ilium once and vertebrae twice); peritoneum, appendix, pararectal lymph glands, Fallopian tubes, vagina, pancreas, adrenals, skin, the vena cava, and the ureter of the opposite side once each. It will be noted that in only 8 cases the metastases extended above the diaphragm.

*Microscopic Diagnosis.* Various terms were used to describe the non-papillary flat tumors which occurred in 7 instances. The distinctly squamous tumors numbered 15, while carcinoma and adenocarcinoma were recorded twice each. Carcinosarcoma was diagnosed once in Renner's case. Fourteen tumors were described as papillary in structure.

The tumors coincident with calculi are of special interest as their presence as a source of chronic irritation is beyond doubt. The association of calculi and tumors was noted in 15.3 per cent of the series. Six such reports are given by Davy 1884, Zironi 1909, Paschkis 1910, Volante 1927, Rousselot and Lamon 1930, and Cochems and Grauer, 1935. In the reports of Davy and

Paschkis the tumors were papillary while the remaining 4 were flat or squamous in structure.

MacMillan and I found the closely related tumors of the renal pelvis to be highly malignant and associated with calculi in 52 per cent of 57 cases. We feel that the early removal of impacted calculi should be considered as a prophylactic procedure.

*Associated Diseases and Double Primary Tumors.* Cross found pulmonary tuberculosis present in the autopsy of his forty-eight year old male patient. Microscopic evidence of syphilis was observed in Renner's seventy-one year old male patient. Ockerblad and Hellwig stated their patient had been cured of an epithelioma of the nose five years previous to operation, although microscopic evidence was not definitely stated. In both Renner's, and Cochems and Grauer's reports associated spindle cell sarcoma of the bladder was noted, while Rousselot and Lamon observed a dermoid cyst of the ovary and adenomyosis of the Fallopian tubes in a forty-eight year old Negress. Hunter's patient, a male, forty-three years of age, lived six years after operation for a papillary carcinoma of the right ureter, only to die of a perforated colloid carcinoma of the stomach. Scott's second case died following an exploratory abdominal operation with colostomy about three and a half months after nephrectomy for hydro-nephrosis. Autopsy disclosed two primary cancers; one of the transverse colon and the other of the lower third of the right ureter.

These cases of multiple primary tumors clearly show the necessity for complete autopsy studies. Six cases or 15 per cent is unusually high in any series of autopsy statistics.

*Prognosis.* There are 6 records with incomplete data in regard to the duration of previous symptoms. Of the 35 cases with complete data, 19 or 54 per cent lived a total of two to nine months. Excluding the 2 cases with long histories there were

14 patients, or 40 per cent who lived from one to three years. The total length of life of the entire series from the onset of the first symptom to the time of death was twenty-one months. With the exclusion of the reports by Israel and Loewenstein (ten years) and Cochems and Grauer's (fifteen years) the total length of life was exactly one year.

The surgical figures of Scott also showed a postoperative mortality of 27 per cent, and the follow-up revealed that more than 50 per cent died within twelve months.

Scott's questionnaire on surgical end-results revealed the fact that 2 and probably 3 patients had survived removal for primary ureteral cancer more than five years after operation. Kraft in 1922 reported the result of nephroureterectomy for multiple papillary epithelioma in a fifty-two year old woman. Follow-up in July, 1932, revealed the patient alive eleven years after operation. Crance and Knickerbocker in 1924 made a preoperative diagnosis of primary tumor of the lower right ureter in a forty-three year old woman who had symptoms for one year. Ureteronephrectomy revealed an epithelioma, and the patient was reported well eight years later. Stewart's patient in 1926, a seventy-five year old woman lived four years after nephrectomy and ureterectomy for papillary cancer of the middle right ureter. Death occurred from pneumonia and cardiac failure. While no autopsy was performed, the disease was probably arrested.

The only addition to these successful surgical results is the report of Hunter in 1935. His forty-three year old male patient survived ureterectomy for papillary carcinoma of the lower third of the right ureter for six years and three months from the onset of the initial hematuria. Death was due to a colloid cancer of the stomach with metastases to the omentum.

It should be noted that 3 of these 4 cases were papillary carcinomas and that in all reports the authors suspected the correct diagnosis preoperatively and followed well planned surgical procedures.

#### SUMMARY

The literature of 40 autopsy cases of primary cancer of the ureter is reviewed to which is added the only report from the Bellevue Hospital files of 22,810 protocols. There were 24 males and 17 females. The peak of the age incidence is in the fifth decade with the average at fifty-seven years. All patients except one were white. The average duration of symptoms previous to observation was fifteen and one-half months. Two reports of extremely long previous histories are given for ten and fifteen years, respectively. Pain, hematuria, and palpable tumor were the three most constant findings in the history and physical examination. Backache was the chief symptom in 6 cases. Cystoscopy and roentgenogram directly aided in making a correct diagnosis 16 times, while associated calculi were found 6 times, or 15 per cent. The tumor was right sided 17 times and on the left 24 times. The lower third of the ureter on both sides was the seat of the tumor in 77 per cent of the series, in 2 cases being localized entirely to the ureter. In 13 reports there was no local extensions but distant metastases were present, while 11 showed no metastases. The metastases were variously distributed to the abdominal viscera and bone, but only 8 times extended above the diaphragm. Twenty-seven primary tumors were flat or non-papillary while 14 were papillary. Six or 15 per cent showed double primary tumors. Nineteen or 54 per cent of patients lived from two to nine months from the onset of the first symptom, while 14 or 40 per cent lived from one to three years. One six year survival is added to 3 previously reported surgical results where apparent successful removal was accomplished.

I wish to thank Dr. Douglas Symmers for his review of the autopsy material.

#### REFERENCES\*

WIESING, P. J. and BLIX, C. Primary cancer of the right ureter. *Hygieia*, 40: 468, 1878.

\* This is a complete bibliography for all recorded autopsies.



- DAVY, R. Clinical lecture on excision of the left kidney. *Brit. Med. Jour.*, 2: 757-758, 1884.
- JONA, G. Beitrag zu den primären Tumoren des Ureters. *Centralbl. f. allg. Path. u. path. Anat.*, 5: 650-662, 1894.
- VOELKER, A. V. Primary carcinoma of the ureter. *Tr. Path. Soc. London*, 46: 133-135, 1894-1895.
- HEKTOEN, L. Primary carcinoma of the ureter. *J. A. M. A.*, 26: 1115-1117, 1896.
- RUNDLE, H. Epithelioma of the ureter causing hydronephrosis. *Tr. Path. Soc. London*, 47: 128-132, 1896.
- GERSTEIN, K. Ein Fall von primärem Krebs der rechten Uretermündung. *Kiel I.D.* 1902, p. 17.
- MINICH, C. K. Carcinoma uretaris, fornicem vaginae perforans. *Pest. Med.-Chir. Presse.*, 38: 941, 1902; *Orvosi beil. Budapest*, 46: 403, 1902.
- St. Thomas Hospital. Carcinoma of the left ureter. *St. Thomas Hosp. Report*, 32: 96, 1904.
- ADLER, L. Beitrag zur Kenntnis der primären Tumoren des Ureters. *Monatsber. f. Urol.*, 10: 129-142, 1905.
- VORPAHL, K. O. F. Ueber ein primäres Karzinom des Ureters. *Greifswald I. D.* 1905, p. 31.
- RICHTER, J. Primäres Karzinom des rechten Ureters. *Ztschr. f. Urol.*, 3: 416-422, 1909.
- ZIRONI, G. Cancer primitive de l'uretère droit. *Ann. d. mal. des org. gen.-urin.*, 1: 81-101, 1909.
- PASCHIS, R. Primärer Tumor des Harnleiters. *Wien. klin. Wchnschr.*, 23: 361-362, 1910.
- LOEWENSTEIN, E. Ein Fall von primärem Karzinom des Ureter. *Freiburg I. D.* 1911, p. 29.
- BUTLER, F. A. A case of primary carcinoma of the ureter with "sciatica." *Clifton Med. Bull.*, 2: 48-51, 1914.
- SPIESS, P. Die primäre epitheliale Tumoren des Nierenbeckens und des Ureters. *Centralbl. f. allg. Path. u. path. Anat.*, 26: 553-618, 1915.
- SCHMIDT, E. G. Primary carcinoma of the ureter. *Jour. Cancer Res.*, 1: 461-478, 1916.
- KNACH, Fall von papillärem Karzinom des linken Ureters. *Deutsch. med. Wchnschr.*, 18: 982, 1918.
- MEEKER, L. H. and MCCARTHY, J. F. Primary carcinoma of the ureter. Report of a case with review of the literature. *J. A. M. A.*, 81: 104-109, 1923.
- GLAS, R. Ein Beitrag zum primären und metastatischen Ureterkarzinom. *Wien. med. Wchnschr.*, 39: 1145-1149, 1926.
- VOLANTE, F. Contributo allo studio dei carcinomi primitivi dell'uretere. *Arch. ital. di urol.*, 4: 103-132, 1927.
- KLAGES, F. Beiträge zum primären Ureterkarzinom. *Ztschr. f. Urol.*, 28: 413-428, 1929.
- ASCOLI, R. Su di un caso di carcinoma primitivo dell'uretere studio iniziale. *Arch. ital. di urol.*, 6: 611-623, 1930.
- OCKERBLAD, N. F. and HELWIG, F. C. Primary carcinoma of the ureter. Report of a case. *Jour. Urol.*, 24: 451-459, 1930.
- ROUSSELOT, L. M. and LAMON, J. D. Primary carcinoma of the ureter. *Surg., Gynec. and Obst.*, 50: 17-28, 1930.
- CROSS, J. B. Carcinoma of the ureter. *Jour. Med. Assn. Georgia*, 20: 125-127, 1931.
- MARRIANI, G. Sopra un caso di cancro primitivo dell'uretere. *Atti d. R. Univ. dei fisioc. Siena.*, 5: 341-352, 1931; *Abst.: Centralbl. f. allg. Path. u. path. Anat.*, 54: 178-179, 1932.
- RENNER, M. J. Primary malignant tumors of the ureter. *Surg., Gynec. and Obst.*, 52: 793-803, 1931.
- NAVRATH, E. Primäres Ureterkarzinom. *Zentralbl. f. Gynäkol.*, 56: 1116-1120, 1932.
- SOMMER, R. Primäres Ureterkarzinom mit metastatischem Verschluss des anderen Ureters. *Ztschr. f. Urol.*, 26: 1-9, 1932.
- SAUER, H. von. Zur Klinik und Pathologie der primären Uretertumoren. *Ztschr. f. urol. Chir.*, 34: 165-178, 1932 (Case No. 1).
- GILBERT, J. B. Primary carcinoma of the ureter. Case report and brief review of the literature. *Surg. Clin. N. Amer.*, 13: 448-493, 1933.
- SNYDER, W. H. and WOOD, B. S. Primary carcinoma of the ureter with report of a case. *Jour. Urol.*, 29: 577-585, 1933.
- HARRAH, F. W. Primary carcinoma of the ureter, with report of two cases. *Amer. Jour. Surg.*, 26: 550-560, 1934.
- SCOTT, W. W. Primary carcinoma of the ureter. *Surg., Gynec. and Obst.*, 58: 215-227, 1934 (Case No. 2).
- COCHENS, F. M. and GRAUER, T. P. Squamous cell carcinoma, leukoplakia and concretions of a megalo-ureter. *Jour. Urol.*, 34: 106-110, 1935.
- HUNTER, A. W. Primary tumor of the ureter; end results in three cases. *Jour. Urol.*, 33: 443-455, 1935.
- MATHE, C. P. and DE LA PENA, E. Primary carcinoma of the ureter. *California and West. Med.*, 42: 357-363, 1935.

## ADDITIONAL REFERENCES

- CRANCE, O. M. and KNICKERBOCKER, H. J. Primary carcinoma of the ureter; report of a case. *J. A. M. A.*, 82: 1930-1932, 1924.
- GILBERT, J. B. Primary cancer of the ureter associated with ureteritis cystica. Case report with special reference to its etiology. *Urol. and Cutan. Rev.*, 40: 191-195, 1936.
- GILBERT, J. B. and MACMILLAN, S. F. Cancer of the kidney, squamous cell carcinoma of the renal pelvis with special reference to etiology. *Ann. Surg.*, 100: 429-444, 1934.
- KRAFT, S. Faele von primärem und sekundärem Ureterpapillom. *Ztschr. f. urol. Chir.*, 16: 385-392, 1922.
- MORSE, H. D. The etiology and pathology of pyelitis cystica ureteritis cystica, and cystitis cystica. *Amer. Jour. Path.*, 4: 33-49, 1928.
- PACK, G. T. and LE FEVRE, R. G. The age and sex distribution and incidence of neoplastic diseases at the Memorial Hospital, New York City. *Jour. Cancer Res.*, 14: 167-294, 1930.
- PATCH, F. S. The genesis and development of Brun's nests and their relation to cystitis cystica, cystitis glandularis, and primary adenocarcinoma of the bladder. *Canadian Med. Assn. Jour.*, 33: 597-606, 1935.
- STEWART, R. L. Primary tumors of the ureter. *Brit. Jour. Surg.*, 13: 667-682, 1926.

# HYDRONEPHROSIS DUE TO BALL-VALVE OBSTRUCTION FROM BULLET LYING FREE IN RENAL PELVIS

JAMES A. H. MAGOUN, M.D.

TOLEDO, OHIO

RECENTLY Campbell<sup>1</sup> reported a case of a hydronephrotic kidney caused by a papilloma of the renal pelvis. Occasionally a stone lying free in the renal pelvis may, through a ball-valve action, cause obstruction to the outflow of urine, producing a hydronephrosis, but in the case here presented this was caused by a bullet.

A female, aged fifty-nine years, was admitted to the Lucas County Hospital on January 24, 1935, complaining of pain in the abdomen and back. Seventeen years ago she was shot in the right upper portion of the abdomen; an operation was performed immediately but the bullet was not found. She made an uneventful convalescence. A few years later, however, she began to have frequency, burning on urination, and pain in the lower abdomen, especially on urinating. There was no hematuria at this time but she thinks that there was blood in her urine directly after the injury.

Eleven days ago she began to have a sharp, severe pain in the right lumbar region with radiation toward the bladder and an exacerbation of the dysuria.

Inspection revealed a fairly well nourished female apparently suffering pain. Examination revealed a few rales in the right lung, tenderness in the region of the right kidney, and a scar over the upper right rectus. The systolic blood pressure was 140 mm. of mercury and the diastolic 80 mm. The urine revealed a trace of albumin and many pus cells. The hemoglobin was 91 per cent, red blood cells 4,400,000, white blood cells 6200. The Kline test was negative. The non-protein nitrogen was 30 mg. per 100 c.c. of blood. The phenolsulfonphthalein test showed 75 per cent elimination in two hours.

A roentgenogram of the kidneys, ureter, and bladder revealed a shadow in the region of the

right kidney, apparently a bullet, and another shadow in the right lumbar region below the crest of the ileum. Cystoscopic examination showed a diffuse cystitis. Both of the ureteral openings were edematous. A No. 6 catheter was passed easily up the left ureter and a left pyelogram was made which was normal. An intravenous urogram demonstrated a normal left kidney with no appearance on the right side. Another cystoscopy was then done and a Braasch bulb placed in the lower right ureter and a right urogram made. This showed the lower shadow to be included in the lower ureter and the upper shadow to be included in the upper ureter and renal pelvis. A diagnosis was therefore made of a calculus in the lower right ureter and a bullet in the region of the right kidney.

Operation was performed on August 15, 1935 employing spinal anaesthesia. An incision was made in the right costovertebral angle downward and medially to a point about one inch above the anterior-superior iliac spine and the kidney was dissected free from its fatty capsule. In attempting to separate the fat from the region of the pelvis of the kidney considerable scar tissue was encountered, probably due to the former gunshot wound. By means of blunt and sharp dissection the kidney was isolated except for its pelvis and inferior and superior poles. The tissue holding the poles was doubly clamped and divided, the distal ends being tied with No. 2 plain catgut. By means of blunt dissection the course of the ureter was uncovered well down toward the pelvic brim. About the level of the pelvic brim a stone was palpated, which was about  $1\frac{1}{2}$  inches long and  $\frac{1}{2}$  inch in diameter. An incision was made over this stone in a longitudinal direction, the stone removed and the incision closed. About 3 inches above this opening the ureter was isolated, triply clamped and divided. The distal portion was doubly tied with No. 2 chromic catgut. The ureter was then freed in its proximal portion until the pedicle of the kidney was exposed. An accessory vessel was found

<sup>1</sup> CAMPBELL, MEREDITH F. Hydronephrosis due to ball-valve obstruction by papilloma at ureteropelvic junction. *Am. Jour. Surg.*, August, 1936. Page 291.

near the inferior pole of the kidney; it was doubly clamped and divided, the lower clamp being left in place. A large kidney clamp was

is nearly as large as the rest of the kidney and a hard object, resembling a bullet, moves freely around in the pelvis. There is a definite hard



FIG. 1. Normal urogram of left kidney with bullet appearing in the upper right abdomen.



FIG. 2. Retrograde urogram of right kidney and ureter showing inclusion of bullet and suspicious shadow (stone) in lower ureter.

then placed on the pedicle and two additional clamps were placed distally, clamping off the width of the pedicle. The kidney was then excised distal to the clamps. A rubber dam drain was placed well down in the right flank. Using No. 2 chromic catgut an attempt was made to close the transversalis, locking the sutures around the drains and clamps. The tissue was, however, so friable that this line of suture was practically worthless. The internal oblique muscle and fascia were closed with No. 2 chromic catgut; the external oblique and latissimus dorsi muscles were likewise approximated with No. 2 chromic, and three silkworm gut tension sutures were placed. Clamps were each tied together with No. 2 plain catgut to prevent their opening. The skin was closed with clips; the dressing was secured by adhesive tape. A pasteboard box covering for the four clamps was secured by tape. The clamps were removed in seventy-two hours.

The pathologist's report is as follows: The specimen consists of a kidney with considerable surrounding fat, and measures 8 by 3.5 by 2.7 cm. The renal pelvis bulges downward and

scar on the greater curvature, thought to be the point at which the bullet entered the kidney. On incising the kidney in the usual manner and opening the pelvis, the bullet is readily released, since it lies free in the pelvis. It appears to be a .38 caliber bullet, the diameter is about  $\frac{5}{16}$  of an inch, the length is about  $\frac{5}{8}$  of an inch, and the bullet is only slightly distorted. The scar on the cortex which is suggestive as being the point of entry of the bullet contains a subcortical stone, the size of a grain of puffed wheat, and there is no track to indicate the course of the bullet. There is another stone the same size in a nearby calyx. The kidney substance shows areas of chronic infection with very little good renal tissue remaining. The pelvis shows several inflammatory patches.

There was received separately a stone somewhat the shape of the bullet, measuring 2.5 cm. in length and 1.3 cm. in diameter and said to have been in the lower ureter.

**Diagnosis:** Hydronephrotic kidney with .38 caliber bullet lying free in the pelvis; ureteral stone.

The convalescence was uneventful and the patient left the hospital in good condition and relieved of her former symptoms.

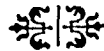
A bullet lying free in the pelvis of a kidney is, to say the least, unusual. Whether the bullet entered the kidney at the time of the shooting or burrowed in later is problematical. I believe, however, in view of the hematuria, which probably occurred, that the kidney was injured in the first instance. The occurrence of the stone lower down in the ureter below the obstruction may have some relationship to the stasis, infection and chemical changes in the urine that undoubtedly resulted from the bullet in the pelvis.

Morris<sup>2</sup> relates several cases from the Napoleonic wars in which there was a bullet wound of the kidney and weeks or months later the patient passed shreds of clothing from the urethra. The records of the World War in regard to bullet wounds of the kidney have not been reviewed but it would be interesting to learn if this type of injury has occurred.

#### SUMMARY

The article is a report of a woman who years before was shot in the abdomen. The bullet evidently lodged in the renal pelvis and through a ball-valve action caused hydronephrosis and destruction of the kidney.

<sup>2</sup> MORRIS, HENRY. *Diseases of the Kidney and Ureter*. Vol. 1, pp. 230 and 231.



# PLASTIC RESTORATION FOR LOSS OF ALL FINGERS OF BOTH HANDS

S. L. HAAS, M.D.

Shriners Hospital for Crippled Children

SAN FRANCISCO

THE loss of all the fingers of both hands is a disabling occupational injury.

All the delicate and dextrous movements which depend upon the highly specialized mechanism of normal finger motion are permanently lost. The stump of either hand alone is useless and to perform any kind of work it is necessary to place the two together. With the two stumps in apposition many gross acts may be accomplished but those requiring finer movements are impossible.

If we wish to obtain additional function it is possible by plastic surgery to transform the metacarpals into fingers. Several factors that have an influence in the results must be taken into consideration when planning the operations. In the first place the mobility of the newly formed member will naturally be restricted on account of the limited range of motion that exists at the metacarpocarpal joints. Then there is usually a considerable amount of scar tissue present that adds to the difficulty of the operation and hinders motion. It is also important that there be sufficient good functioning muscle to control the movement of the new digit and there should be a normal sensory nerve supply.

The brief history of a boy with loss of all the fingers, together with an outline of the operation will be reported.

E. C. L., aged eleven years, male, at the age of one and one-quarter years, or nine and three-quarter years ago, fell into hot ashes and received severe burns of both hands. Nothing is known about the immediate or subsequent treatment. The fingers were burned at their ends and became buried beneath a covering of skin. During the ten years following the accident the patient became quite adept in the use of the two stumps of hands when held together and could cut his food, comb his hair and do

many useful things in a remarkable manner. With one stump alone he could do very little.

*Examination.* There are no visible fingers on either hand. The burnt off stumps of the fingers are buried beneath a covering of skin and fibrous tissue (Fig. 1). On the left hand there is good extension and flexion of the wrist. When the patient attempts to move the stumps one can feel beneath the skin the remnants of the first phalanges of the third, fourth and fifth fingers moving fairly well at the metacarpal-phalangeal joints. There is little motion between the first phalanx on the second metacarpal bone but practically none in the first metacarpal-phalangeal stump. On the right the wrist is held in a position of about 35 degrees of flexion and ulnar deviation. The buried remnants of the fingers are much more fixed than on the opposite side and several of the stumps appear to be fused to each other. In the roentgenogram (Fig. 2) one sees several of the first phalanges present. They are flexed at the metacarpal-phalangeal joint.

*Treatment.* There was a total of thirteen anesthetics and several operations were carried out at the same time.

*First operation,* December 14, 1932, right hand. (1) Release of wrist contracture. The scar tissue was resected and the gap filled with a split skin graft. (2) Plastic to form thumb.

*First Stage.* Dorsal and plantar flaps were outlined between the first and second metacarpal bones and a cleft was formed by cutting down between them. The flaps were sutured in place and the remainder of the gap was filled in with split skin grafts.

*Second operation,* January 30, 1933, right hand. Plastic reconstruction of the thumb: Flaps corresponding somewhat to a Didot operation were formed between the first and second metacarpal bones. The defects were filled in by split skin grafts.

*Third operation,* March 8, 1933, left hand. Plastic between the second and third metacarpal bones: An incision was made between the second and third metacarpals. The defects

in the skin were covered by full thickness grafts obtained from the abdomen.

*Fourth operation, April 7, 1933, right hand.*

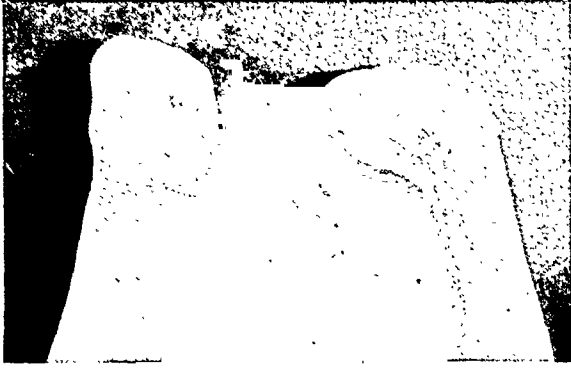


FIG. 1. The appearance of the hands before operation; contracture of right wrist and complete absence of fingers on both hands.

Deepening the cleft between the first and second metacarpal bones: The cleft was deepened and the defects in the skin were covered by full thickness grafts removed from the right thigh.

*Fifth operation, July 5, 1933, left hand.* Deepening of the cleft between the first and second, and between the second and third

*Sixth operation, August 11, 1933, right hand.* Deepening of a cleft between the thumb and the adjoining stump: Flaps were outlined and



FIG. 3A. Four rudimentary fingers were formed on the left and one on the right hand. There was good mobility between the digits.

after cutting down between the metacarpal bones the flaps were shifted to fill in as much as possible of the gap. The remainder of the defect was filled in with split skin grafts.

*Seventh operation, September 25, 1933, right hand.* The cleft was again deepened between the thumb and the adjoining stump and the defect was filled in by shifting flaps and full



FIG. 2. Roentgenogram showing distorted remnant of the proximal phalanges.

metacarpal bones: The clefts were deepened by cutting at the base of the already formed clefts. The defects were covered by shifting flaps of skin, full thickness grafts and split skin grafts.

thickness grafts. A tubular graft was prepared on the abdomen at the same time.

*Eighth operation, November 10, 1933, left hand.* (1) Formation of cleft between the third

## Haas—Plastic Restoration

and fourth metacarpal bones and (2) transference of one end of the tubular graft: The lower end of the tubular graft was freed and

tubular graft: The remaining attachment of the tubular graft was excised and sutured.  
Tenth operation, March 12, 1934, left hand.

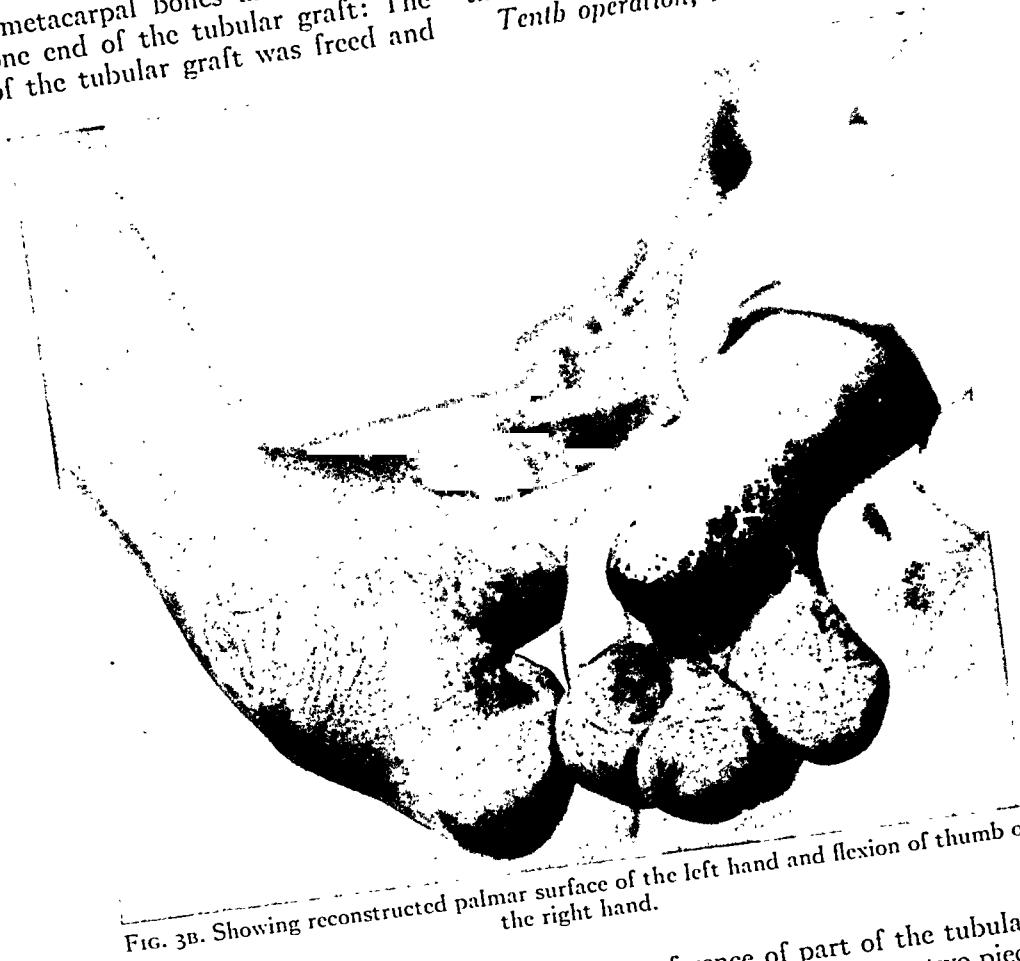


FIG. 3B. Showing reconstructed palmar surface of the left hand and flexion of thumb of the right hand.



FIG. 4. Using knife and fork.

transposed to a bed prepared on the left hand. The bed for its reception was formed by cutting between the third and fourth metacarpal bones.  
Ninth operation, December 13, 1933, left hand. Transference of the remaining end of the

Transference of part of the tubular graft: The tubular graft was cut into two pieces. The part toward the palm was opened up. The scar tissue was resected from the palmar surface of the hand and the opened up tubular grafts were sutured into the defect.

Eleventh operation, April 8, 1934, left hand. Deepening of the cleft between the second and third and the third and fourth finger stumps: Portions of the tubular graft were transferred to the gaps that were formed by cutting deeper between the second and third and third and fourth metacarpal bones.

Twelfth operation, May 16, 1934, left hand. Plastic of the palm between the new stumps: Portions of the tubular grafts were released at advantageous points and shifted between the various stumps and into the palm to replace contracted tissue.

Thirteenth operation, June 27, 1934, left hand. Plastic on the stump; full thickness graft to the palm: Further shifting of flaps was done about the bases of the stump. A defect that was left after this shifting of flaps was filled in by a

full thickness graft that was removed from the left thigh.

The final result was the forming of a rudimentary thumb on the right side, giving the

creep up as after syndactylism operation but this did not take place during the first year. With use the range and freedom of motion should increase.



FIG. 5. Holding golf ball in the left hand.

patient a boxing glove or mitten type of hand (Fig. 3). He attained good movements of the newly formed thumb and could do many useful things such as writing, combing his hair and feeding himself. It was thought inadvisable to attempt to make any other digits on this hand because of the fixation of the joints and the excessive scar tissue.

On the left hand a rudimentary thumb and three fingers were constructed (Fig. 3). Although they appeared thick and bulbous he had very good control over them. He could write, comb his hair, assist in cutting his food and employ his fingers for many useful purposes (Fig. 4). He was able to hold a golf ball in his left hand (Fig. 5). He was learning to lace his shoes and could almost tie a bow knot when he left the hospital.

#### COMMENT

There should be an increased length of the digits as the metacarpals grow and a decrease in the thickness of the members. There is often a tendency for the web to

One of the main difficulties encountered was the tendency toward contracture in the palm following each operation. With each addition of a digit there was an increasing contracture tending to pull the fingers toward the middle of the palm and restrict motion. Fortunately each finger maintained its independent motion after the numerous operations. There were no gross sensory disturbances or tendency toward trophic changes.

#### SUMMARY

The loss of all the distal portion of the fingers on both hands with the forming of a pannus of skin over the stumps furnished the interesting clinical condition reported in this paper. The partial restoration of four digits on one hand and one on the other, allowing independent use of each hand with an increase of function, was obtained by plastic operations.



# BLANK CARTRIDGE CANNON SHOT WOUND OF LEG\*

HERBERT WILLY MEYER, M.D.

Associate Professor of Clinical Surgery, New York Post-graduate Medical School, Columbia University

NEW YORK

**O**CCASIONALLY in civil practice surgeons have an opportunity to treat wounds such as occur in



FIG. 1. Wound of lower leg with exposed shaft of tibia denuded of periosteum.

military service. It may be of interest, therefore, to report a case in which a thirteen year old boy had a serious cannon shot wound of his left leg.

In July, 1933 while at camp in Maine, W. C. O. fired a small, marine cannon as the morning salute to the raising of the flag. The cannon was one of those small type that one sees on board ships and which are used for saluting shots. They are loaded with shot composed of powder and cotton wadding. How this accident occurred is not exactly known but the fact remains that this chap in some manner pulled the cord on the trigger at the moment that his left leg, at the junction of the middle and lower thirds of the mesial aspect, was directly in front of the muzzle of the cannon. The skin, portions of the muscles and all of the covering over the tibia including the peri-

osteum, were blown away by the close range explosive force of the shot. He was rushed to a nearby hospital in Lewiston, Maine, where first aid was given.

Dr. Walter H. Galland of New York was called and upon his arrival in Maine he realized that an extensive reconstruction operation would be necessary to repair the defect of the leg and it was through his courtesy that I operated upon this patient with him. Tetanus antitoxin was given immediately and the patient was transferred to New York where he arrived forty-eight hours after the injury. The leg presented an area of the tibia about 3 inches long completely denuded of its periosteum and the bone charred and burned by the powder (Fig. 1). The surrounding area for about 2 inches beyond the wound margin showed the typical effect of a close explosive injury. The tissues were black, necrotic and devitalized and burned by the powder. The muscles on the inner aspect were exposed and likewise black and charred.

An immediate débridement operation was performed under avertin anesthesia. The leg was thoroughly scrubbed with  $\frac{1}{2}$  per cent lysol and green soap getting rid of as much powder markings as possible. Thereupon, excision of all of the devitalized tissue was done, removing skin, aponeurosis and superficial muscle and cutting through normal healthy periosteum to get a clean edge. This resulted in a wound approximately 6 inches long and 4 inches wide and left a large, exposed area of tibia denuded over half its extent of periosteum. The wound was immediately treated with Carrel-Dakin solution.

The next days were anxiously watched to make sure that no infection along the fascial planes of the leg would occur. Another dose of tetanus antitoxin and gas bacillus serum were given. Fortunately, no infection occurred. Smears of the wound were made and watched for evidence of bacteria.

Dr. Galland and I believed that the sooner the denuded and charred tibia would be covered with normal tissue the greater would be the

\* Presented before the Surgical Section of the New York Academy of Medicine, May 4, 1934.

chance of maintaining or restoring its vitality. The medical and surgical consultants agreed with this and on the third day after the débridement and even before the wound smears were

principles had to be kept in mind in planning the operation.

1. The flap had to be somewhat larger than the actual defect.



FIG. 2. Left leg held in place by plaster-of-Paris cast with window cut out to expose pedicle and flap.



FIG. 3. Close up view of flap healing in place. Thiersch graft healed on undersurface of pedicle. Granulating wound at lower end of flap where sutures were removed at primary operation to release the tension.

free of bacteria a reconstruction operation was undertaken, under avertin anesthesia.

The operation was performed on the Albee fracture table. Of the greatest assistance and a point which we consider of the most vital importance, was the fact that Dr. Galland was associated with us at this operation. The success of these types of cases depends as much on keeping the legs properly immobilized as it does on the operative procedure. It was, of course, essential that this large defect be covered with a pedicle flap composed of normal skin and subcutaneous fat. A Thiersch skin graft or a full thickness graft would never take over this area of denuded and partially devitalized bone. To take a pedicle flap from the posterior aspect of the same leg was impossible as the width of the flap necessary could not be obtained from the posterior aspect of the same leg. Therefore, a pedicle tongue flap from the opposite thigh had to be used. A model of the defect was cut beforehand and was studied carefully so that we knew exactly where to place the pedicle of the flap on the right thigh. A number of important

2. The pedicle had to be long enough to allow the flap to jump across from the thigh to the leg and lie in place without tension.

3. All raw surfaces should be immediately covered with Thiersch skin grafts to obtain complete primary union and to have no resulting granulating wound. This was especially important during the heat of the summer when maggot infection of a secreting wound in a cast occurs so easily.

4. The two legs should be held rigidly together by plaster cast to prevent any motion of the flap or pull on the pedicle.

The large flap from the anterior and outer aspect of the lower portion of the right thigh was then raised with the base of the pedicle above. Skin, fat and superficial fascia were included in the flap exposing the fascia lata over the muscles of the right thigh. After the flap and pedicle were raised the left leg was crossed to test the flap and see whether it would fit into the defect and also whether the pedicle was

long enough. After this was ascertained the skin margins on the right thigh were slightly undermined to permit any decrease in the size



FIG. 4. Right thigh from which pedicle flap was taken. Thiersch graft on outer and inner aspect of thigh. Picture was taken one month after operation.

of the defect by suturing the skin edge to the fascia lata. It was impossible to decrease this wound very much in size. The entire raw surface was then covered with Thiersch skin grafts carefully taken from the left thigh. The edge of the wound was covered with a narrow strip of tampon on which some 1 per cent fuchsin ointment had been applied. Where Thiersch grafts overlapped one another a similar strip of gauze was laid. The whole grafted area was then covered with gauze which was most meticulously strapped with sterile adhesive to prevent any shoving of the Thiersch skin grafts. This was necessary as we knew that the grafted area could not be dressed for some time. In another similar case it would be well to place a rubber sponge between the leg and the thigh to act as a soft cushion or a pedestal on which the leg rests.

A Thiersch graft was also placed on the raw undersurface of the pedicle of the flap and held in place with sutures of interrupted plain cat-

gut. The left leg was then brought across the right thigh and the flap found to fit perfectly into the defect. It was sutured in place with interrupted black silk sutures except where the pedicle crossed the defect. After suturing the flap in place it was found that its lowermost portion became totally blanched and would be in danger of necrosis. Several sutures, therefore, on the lower portion of the flap were removed, releasing the pressure and allowing some of the fat to be exposed and to be allowed to heal by granulation. Later observation showed that this was most important as we feel quite certain that at least one-quarter of the flap would have been lost if these sutures had not been removed. As soon as sterile dressings had been put in place Dr. Galland applied a plaster spica around the pelvis, the flexed left knee and the right leg down to and including the right foot (Fig. 2).

We wish to emphasize once more that in these types of cases the closest coöperation between a surgeon and an orthopedic surgeon is of utmost importance for their successful conduct. The many buttresses and reinforcements, windows, etc., which Dr. Galland put into this cast made it possible to have the entire flap with its pedicle exposed so that close observation and dressings were technically possible (Fig. 3). Naturally a cast of this type was quite heavy and the patient was placed on a fracture bed in which the mattress could be lowered, permitting bedpans, etc., to be raised under the patient. It also permitted the turning of the patient from side to side, allowing the projecting knee and foot to pass between the canvas straps of the fracture bed. It was necessary to improvise a large rubber tube which had to be passed between the cast and into which the patient urinated, as it was impossible to bring a urinal up to the penis. The following three weeks were difficult for the patient as well as for the nursing staff and the doctors. To lie immobilized in this position during the heat of the summer was no trifle for this young man and he deserves a great deal of credit and commendation for his coöperation.

The wound healed by primary union including the graft on the pedicle of the flap. On the twentieth postoperative day the cast was removed under avertin anesthesia and the pedicle divided, the flap implanted and sutured to the wound margin of the left leg. The only abnormal condition found upon removal of the cast was a small pressure ulcer on the outer side of the left leg where the leg had been in contact

with the padded dressings over the Thiersch grafted area of the right thigh. It was decided at this time to do a further plastic operation on

maintained totally viable and healed normally in place (Fig. 5). The tibia was carefully watched for the possibility of sequestration of the cortex



FIG. 5. A, anterior view and B, lateral view of flap healed in place one month after operation.

the right thigh after excising the Thiersch graft from the remainder of the pedicle and from the thigh so that the remaining pedicle could be replaced into its former position. In order to avoid a non-elastic Thiersch grafted area over the quadriceps extensor muscle directly in front of the right thigh and to allow for better function and elasticity on flexion of the right knee, a further pedicle tongue flap from the inner aspect of the right thigh with the base of the pedicle above was raised and swung across the front of the right thigh. The resulting defect on the inner aspect of the right thigh was then decreased in size by undermining the skin edges and suturing them down to the fascia. The remaining defect was covered with a Thiersch skin graft from the left thigh. This re-arrangement of the tissues of the right thigh then resulted in non-elastic Thiersch grafts on the inner and outer aspects of the right thigh with practically normal elastic skin over almost the entire extent of the front of the right thigh (Fig. 4). All of these wounds healed kindly. The main flap over the gunshot wound area re-

since the cortex had been burned by the heat of the explosion and denuded of periosteum. Repeated observation by x-ray film from month to month showed that the early covering of the bone with the pedicle flap made it possible for the bone to recover and no sequestration took place (Fig. 6).

In the immediate convalescence following the last operation there was some difficulty in regaining flexion and extension of both knee joints and of the ankle joints but this rapidly improved with massage and physiotherapy.

It is now three years since the injury and the operation; the patient has been totally restored to normal function and is able to partake of every form of athletic exercise and goes about his work and play the same as he formerly had done.

#### CONCLUSIONS

This case is reported to bring out a number of points in the treatment of such injuries requiring reconstruction operations.

1. Early and thorough débridement of all injured and destroyed tissues;
2. Early covering of exposed bone especially if denuded of its periosteum;
3. Careful planning and measurement

surgeon in order to get the best complete immobilization of the extremities and still make it possible to expose the flap and dress the wound by properly placed windows in the cast, etc.



FIG. 6. A, tibia one month after being covered with flap; B, tibia six months after operation.

for the proper preparation of the flap and its pedicle;

4. The immediate complete covering of all raw surfaces with Thiersch skin grafts;

5. The vital importance of the association of the surgeon and an orthopedic

6. The covering of the anterior portion of the thigh with normal elastic tissue rather than non-elastic Thiersch graft; and

7. The necessity of close coöperation and teamwork between surgeons, nursing staff and patient.

# INTESTINAL PROLAPSE THROUGH ENTEROSTOMY FOLLOWING RAMMSTEDT OPERATION

JOSEPH K. NARAT, M.D.

Attending Surgeon, St. Elizabeth Hospital

CHICAGO

A MALE, four weeks old, breast fed infant was admitted to the St. Elizabeth Hospital, service of Dr. E. H. Flinn, because of projectile vomiting which began twelve days previously. The baby's abdomen was round and firm; after feedings peristaltic waves were visible passing along the fundus and the cardia, and ending abruptly at the pyloric end. The infant's weight was  $6\frac{1}{4}$  pounds (2.81 kg). All non-essential features are omitted for the sake of brevity. The x-ray study of the gastrointestinal tract showed a marked retention of the barium suspension in the stomach, such as would be due to a hypertrophic pyloric stenosis. As the the S.M.A. formula given by gastric gavage was not retained and belladonna had no effect, the infant was referred for operation. A typical Rammstedt operation was performed under local anesthesia, care being taken not to injure the mucosa. The patient was given father's blood intramuscularly, in addition to subcutaneous injections of glucose and saline solution. The vomiting, no more projectile in character, occurred a few times in course of the next two days and then ceased completely. As the mother's milk was very scanty, it was supplemented by human milk furnished by the Health Department of the city of Chicago.

Eight days after the operation the abdomen became distended and the complexion of the infant turned sallow. In course of the following day the distention assumed threatening dimensions; the overlying skin was as thin as tissue paper and large subcutaneous veins were visible on the chest and abdomen. Flatus were passed freely, defecation was normal, vomiting was absent, the temperature never rose above 100.5 degrees. In spite of such a confusing picture, a suspicion of a paralytic ileus was considered as justified and after a consultation an ileostomy was performed under local anesthesia nine days after the Rammstedt operation. The after-treatment consisted of repeated blood transfusions, hypodermoclysis, injections of pitressin and prostigmin and instillations of saline solution through the catheter placed into the enter-

ostomy opening. The infant was exposed daily to ultraviolet light and was given drysdol.

The operation apparently did not accomplish a decompression. The abdomen remained extremely distended although flatus and feces were passing freely through the artificial stoma and not through the rectum. The respirations were labored. A flat x-ray picture of the abdomen taken eight days after the second operation was reported as follows: "There is a sharply defined pocket of gas in the right upper quadrant, which appears to be free air under the right diaphragm; the pocket displaces the liver downward. The loops of bowel are all collapsed. As a second guess, the findings may be due to a distended, obstructed colon in the hepatic flexure, but the pocket seems too sharply defined." As various conservative measures did not bring any improvement and the infant became highly dehydrated, sixteen days after the enterostomy a needle was inserted under fluoroscopic control under the costal arch in the right axillary region and thick pus aspirated. An incision was immediately made and a rubber drain inserted into the subphrenic abscess cavity. The latter gradually became obliterated and the fistula closed spontaneously after the purulent discharge disappeared.

As the distention of the abdomen subsided only partially and the rectal examination revealed an obstruction 5 cm. above the anus, a diagnosis of a pelvic abscess was made. Four days after the drainage of the subphrenic abscess a mosquito forceps was inserted through the rectum and a cavity opened, from which thick pus escaped. In the course of the following few days the same procedure was repeated several times to maintain drainage. The purulent discharge per rectum stopped after a few days but no feces were passing through the anus. A rectal examination disclosed a stricture, apparently caused by adhesions. Daily gentle dilatations of the stenosis with Hegar's cervical dilators were instituted. Feces began passing through both the rectum

and the artificial stoma in approximately equal amounts but a new complication appeared. The posterior wall of the intestinal loop, attached to the abdominal wall began prolapsing through the enterostomy every time the child cried. Within a short time the evisceration not only became stationary but increased in size. After a few days the sausage-shaped protrusion in the right lower quadrant of the abdomen was 6 cm. long; it had the color of the intestinal mucosa and was covered with mucus. A round opening was visible on either end of the mass, which seemed to be only slightly congested and showed no signs of inflammation. The general condition of the patient was not affected and the infant was gaining weight.

No difficulty was experienced in reducing the prolapse but tight bandaging did not prevent repeated eventrations. A few minute erosions appeared on the surface of the prolapsed mucosa. Fecal masses continued being expelled through the enterostomy as well as through the rectum but the prolapse recurred every day. Three unsuccessful attempts were made to overcome the recurrences by approximating the edges of the wound with deep silkworm sutures. The skin surrounding the stoma was highly macerated in spite of applications of latex, kaolin, etc., and the stitches would not hold. Finally, a rubber sponge was applied to the wound, which immediately stopped the recurrences of the prolapse. The surrounding skin gradually assumed a normal appearance and the enterostomy closed spontaneously.

Two and half months after the first operation the child weighed 9 lb. 2 oz. (4.61 kg.), i.e. it had gained three pounds (1.35 kg.).

#### DISCUSSION

The first observation which attracts attention in this case is the development of peritonitis and paralytic ileus after the Rammstedt operation, in spite of the fact that no visible perforation of the pyloric mucosa was produced. As the pus from the subphrenic abscess contained colon bacilli, it is reasonable to assume that the infection was caused not by an accidental contamination but by a minute leakage of the gastric contents through the exposed mucosa of the pylorus.

Another interesting feature is the failure of the roentgenogram to reveal a shadow indicating the subphrenic abscess, although the overlying gas bubble was visualized. It follows that in suspicious cases an exploratory aspiration or incision is justified even if the x-ray findings are negative.

The most important complication was the eventration of invaginated intestinal loops. Bérard and Chaliér,<sup>1</sup> who were the first to describe a prolapse of intestines through an artificial anus, distinguish two stages of the condition: (1) eversion of the mucosa and (2) formation of a mucous cylinder. Mallet and Martin<sup>2</sup> reported 7 cases and ascribed the prolapse to the suction exerted by Reverdin's receptacle, worn by all their patients. Recently Jaeger<sup>3</sup> observed a similar condition. All cases reported in the literature developed in adults with colostomies of long standing. The mechanism of the development of such a prolapse is illustrated below (Figs. 1 and 2). A vis a tergo, i.e., an increased intra-abdominal pressure pushes the posterior wall of the attached intestinal loop in the direction of the least resistance. Gradually a cylinder forms; it has two orifices, one leading to the afferent, the other to the efferent loop. The external wall of the sausage-shaped mass is formed by the everted mucosa, the internal wall by the serosa, and the stem by the mesentery. If the pressure is sufficiently strong, the cylinder is transformed into a pouch which may serve as a hernial sac for other intestinal coils. A strangulation may develop in such a pouch. As to the pathogenesis of such combined evisceration and intussusception, the following conditions are the determining factors: (1) wide stoma; (2) relaxation or atrophy of the abdominal muscles; (3) vivid motor activity of the opened and fixed intestinal loop;

<sup>1</sup> BÉRARD L. and CHALIÉR, A. *Lyon Chir.*, 2: 96, 1909.

<sup>2</sup> MALLET-GUY P. and MARTIN, E. *Journ. de Chir.*, 34: 425, 1929.

<sup>3</sup> JAEGER, F. *Bruns' Beitr. z. Klin. Chir.*, 163: 539, 1936.

(4) increased intra-abdominal pressure; and (5) long mesentery.

Contrary to other observations described in the literature, the complication devel-

## SUMMARY

A Rammstedt operation for a pyloric stenosis was performed on a four weeks

Figure 1

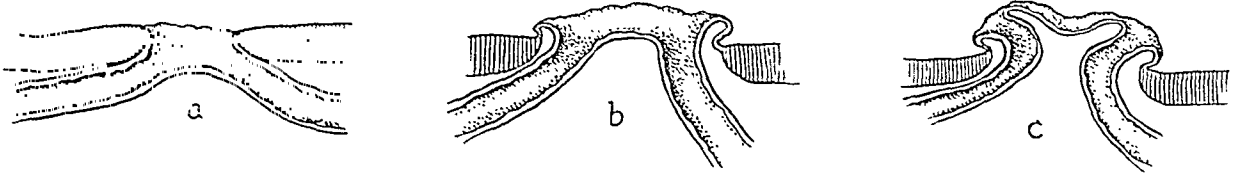


Figure 2

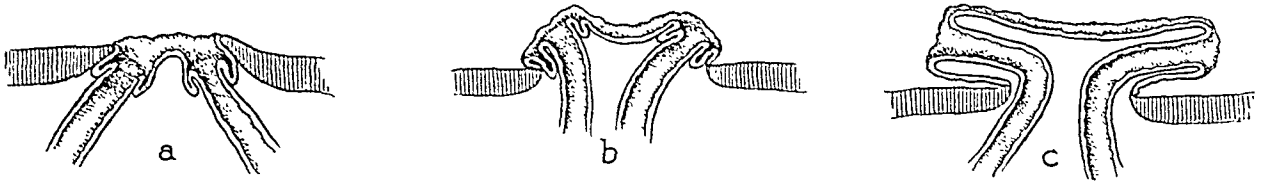
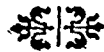


FIG. 1. Prolapse of intestines through an artificial anus. a, enterostomy; posterior wall begins to bulge; b, eventration more pronounced; c, complete eventration of both stomata.

FIG. 2. Intussusception and evisceration through an artificial anus. a, intussusception of the afferent and efferent loops; b, intussusception combined with incipient evisceration; c, intussusception and evisceration completed. Note: This mechanism results in a protrusion of a much larger loop than a simple bulging of the posterior wall of the attached gut, as illustrated in Figure 1.

oped in an infant and not in an adult; in an ileostomy and not in a colostomy; in a relatively recent stoma and not in an artificial orifice of a long standing. Pads and tight dressings, recommended by writers on this subject, proved useless in the author's case. A rubber sponge accomplished the desired effect, probably by exerting a continuous elastic pressure and absorbing moisture, thus preventing maceration and contributing to an increased strength of the abdominal wall.

old infant. One week later a paralytic ileus necessitated an enterostomy. Six days after this second operation a subphrenic abscess and four days later a pelvic abscess were drained. On the top of all these complications a prolapse of invaginated afferent and efferent loops developed through the enterostomy opening. A rubber sponge applied over the stoma proved effective in the prevention of recurrences of this intussusception and eventration. A spontaneous closure of the enterostomy followed.





# NEW INSTRUMENTS

## MECHANICAL HOLDER FOR RETRACTORS IN NEUROSURGERY

WALLACE B. HAMBY, M.D., F.A.C.S.

Instructor in Surgery, University of Buffalo School of Medicine; Surgical Staff, Buffalo General and Buffalo City Hospitals

BUFFALO, N. Y.

WORKING through skull defects of limited size upon structures often situated at considerable depth, neurosurgeons frequently employ electrically lighted retractors to obtain adequate visualization of surgical lesions. Due to the narrow field of view the assistant generally is unable to keep the lesion in view constantly so the surgeon is obliged to hold the retractor for himself. This forces him to operate with one hand while the use of both is more desirable. This is particularly necessary when the organization of the

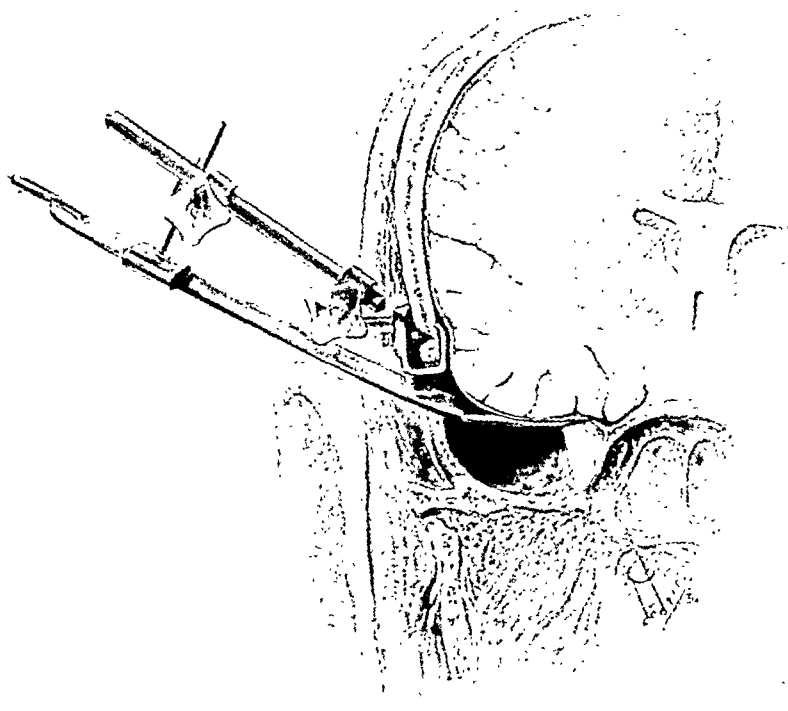


FIG. 1. Exposure of the gasserian ganglion by a lighted retractor and the mechanical holder.

neurosurgeons frequently employ electrically lighted retractors to obtain adequate visualization of surgical lesions. Due to the narrow field of view the assistant generally is unable to keep the lesion in view constantly so the surgeon is obliged to hold the retractor for himself. This forces him

to operate with one hand while the use of both is more desirable. This is particularly necessary when the organization of the operating clinic does not provide for assisting members of the team to remain on service long enough to learn to render the most efficient assistance.

In other fields of surgery self-retaining retractors have been employed to advantage. Dr. A. J. Crawford of Detroit,

Michigan, has devised an instrument made on the principle of a self-retaining orificial speculum for visualization of the gasserian ganglion. Although I have not been able to find a reference in the literature, it has come to my attention that Professor Th. de Martel of Paris has devised an efficient instrument for retaining retractors in neurosurgery.

The instrument here described was made to hold the retractors commonly used in neurosurgery, thus allowing the surgeon the use of both hands for operating. It consists of a clamp that is attached securely with a screw to the edge of the bone defect outside the dura. This remains in place throughout the operation. The blade of the lighted retractor is slipped into a slot in the holder where it is retained by friction. These two parts are joined by a connecting rod and two thumb screw joints allowing a universal range of motion. When the retractor tip is placed in the proper posi-

tion, the two thumb screws are tightened by an assistant and the retractor is fixed rigidly in place, leaving the surgeon's hands free for operating. The position of the retractor is easily changed by loosening the two thumb screws and redirecting it, after which the screws again are tightened.

Originally made for exposure of the gasserian ganglion and its sensory root in trigeminal rhizotomy, the instrument has proved useful for retracting the cerebellum when removing acoustic neurinomas and for maintaining exposure of lesions in the neighborhood of the sella turcica. One or more of the retractors may be so secured when several are required for exposure of other intracranial lesions, with diminution of trauma to the cortex that sometimes results from the varying pressure exerted by the hand of an assistant. The time consumed in adjustment of the instrument is negligible in view of the excellent exposure obtained.



# NEW INSTRUMENT FOR INTESTINAL ANASTOMOSIS\*

## PRELIMINARY REPORT OF EXPERIMENTAL WORK

FRANK GLENN, M.D.

NEW YORK

OVER 250 different methods of resecting segments of intestine and uniting the divided ends have been

trauma to the intestinal wall, contamination of the field of operation and post-operative intestinal obstruction have not been solved satisfactorily.

In an effort to find a means of avoiding these difficulties, experiments on end-to-end anastomoses have been performed for some years. The original experimental work was done by Halsted, who used the bulkhead principle in cutting through the inverted, closed ends of the bowel. Horine, Fraser and Dott and others worked on a simplification of Halsted's method and following the same principle, Burket and McClure continued the research which forms the basis for the study to be described briefly.

Burket and McClure employed a wire loop similar to a tonsil snare to cut through the closed stumps of bowel. The procedure necessitated the withdrawal of the snares through the line of sutures which united the intestinal ends. As the wires were withdrawn they tended to drag the submucosa with them into the metallic tube; also, the operation frequently left a wide cuff of intestinal wall within the lumen. To obviate these difficulties, a diaphragm of knife-blades and various kinds of loop sutures later were tried without complete success.

The instrument to be described is constructed on the principle of the snare employed by Burket and McClure but it circumvents some of the difficulties encountered by these authors. It consists of two wire snares with attachments to a Bovie unit. The snares operate through bakelite tubes which can be held in close alignment in a specially constructed cross-bar clamp. The instrument (Fig. 1) is used in the following manner: A snare is placed

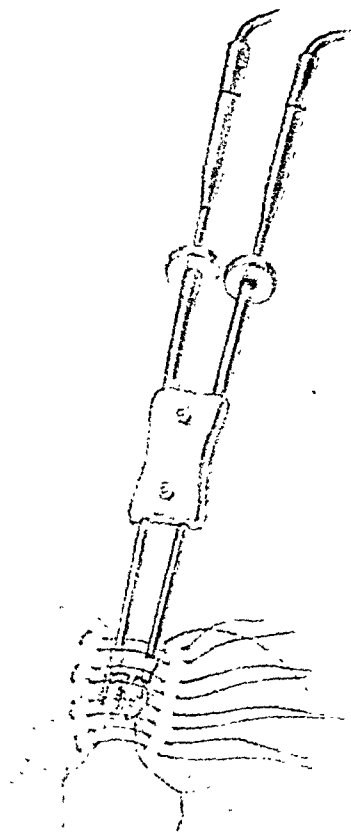


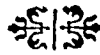
FIG. 1. The instrument is shown after the resection of a segment of bowel, with the stumps held in alignment. The bakelite tubes through which the snares operate are in position in the special cross-bar clamp.

reported in the literature; had any of these been entirely satisfactory it would be superfluous to present new procedures. However, the problems of preventing

\* From the Department of Surgery of the New York Hospital and Cornell Medical College.

at each extremity of the segment of bowel to be resected after the mesentery has been divided and the blood vessels ligated. By means of set-screws, the snares are tightened until they obliterate the lumen of the intestine. Using the cautery, the intestine is divided close to the snares and removed with its mesentery. The stumps of bowel held in the snares are now brought into alinement by approximating the bakelite tubes and are secured in this position by fitting the tubes into the cross-bar clamp. The divided ends of bowel are brought together with mattress sutures, one of

which is placed so that it embraces the snares. Beginning with those closest to the mesentery, all sutures are tied with the exception of the one embracing the snares. The connection with the Bovie unit is made now and the current through the snares cuts cleanly through the inverted stumps of bowel, leaving within the lumen a very small amount of untraumatized intestinal wall. The instrument is now discarded and the last mattress suture tied. Reinforcing sutures are placed between the mattress sutures and the abdomen is closed in the routine manner.




---

IN 1737 the University of Göttingen ("Georgia Augusta") was formally opened (September 17), and the Royal Medical Society of Edinburgh was founded.

---

IN 1837 Gerhard differentiated between typhus and typhoid fevers. Colles stated the law of maternal immunity in syphilis. Jacob Henle described epithelial tissues. Rush Medical College (Chicago) was founded. K. k. Gesellschaft der Aerzte was founded at Vienna.

---

IN 1437 Eugenius IV chartered the University of Caën. In 1137 St. Bartholomew's Hospital (London) was founded by Rahere.

---

IN America men of great financial resources have outpaced foreign governments in liberal endowments for scientific and medical research.

From—"History of Medicine" by Fielding H. Garrison, M.D.

# DEVICE FOR TIGHTENING WIRE FOR BONE FIXATION

JOHN A. CALDWELL, M.D.

Professor of Clinical Surgery, College of Medicine, University of Cincinnati

CINCINNATI, OHIO

THERE are many situations which arise during open operations for fixation of bones where wire is the worse, is strained to the breaking point and breaks later when stress is applied. The device illustrated has proved very



FIG. 1. Wire fastened in instrument and tightened. A, threaded stem; B, lock nut; C, knurled wheel.

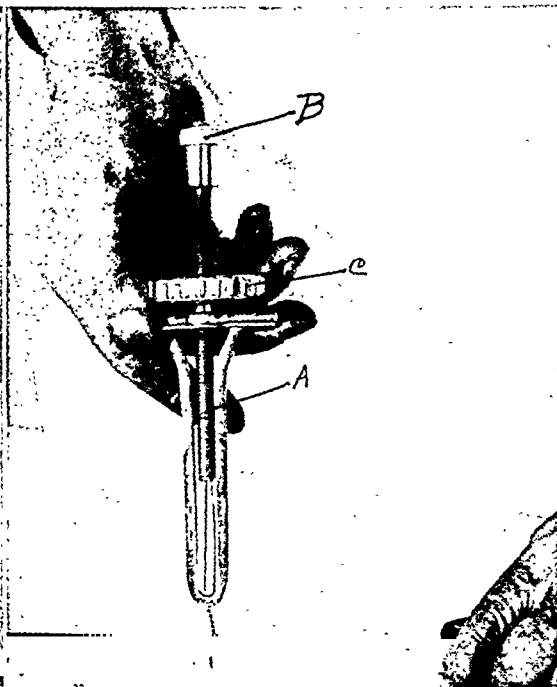


FIG. 2. Wire locked by twisting entire instrument. A, threaded stem; B, lock nut; C, knurled wheel.

best material for holding the fragments. A notable example is where the fracture is committed near a joint and involves cancellous bone. Screws will not hold in such structure and it is not always feasible to use a bolt.

Where wire is used there is always the difficulty of tightening it by twisting without breaking it. Tightening a wire by twisting the ends together is bad practice because the wire is frequently broken or,

satisfactory since it was first tried. The wire is passed through the threaded stem, A, and locked by the lock nut, B, at the top. It is then tightened by running the knurled wheel, C, down the threaded stem until the resistance felt to turning indicates that the wire is tight enough. It is then twisted by turning the entire instrument and at the same time loosening the lock nut.

An advantage which the instrument possesses is that it can be used in a deep or small incision.



## THE KUT-KLAMP

# A NEW SURGICAL INSTRUMENT WHICH SIMULTANEOUSLY CUTS AND RETAINS A SUTURE\*

DAVID I. SOLOMON, M.D.

NEW YORK

THE conventional technique of handling retention sutures in surgery is to clamp the suture about 4 inches

The Kut-Klamp is shown in detail in the accompanying drawing.

From the lock, 5, to the end loops, 6, it

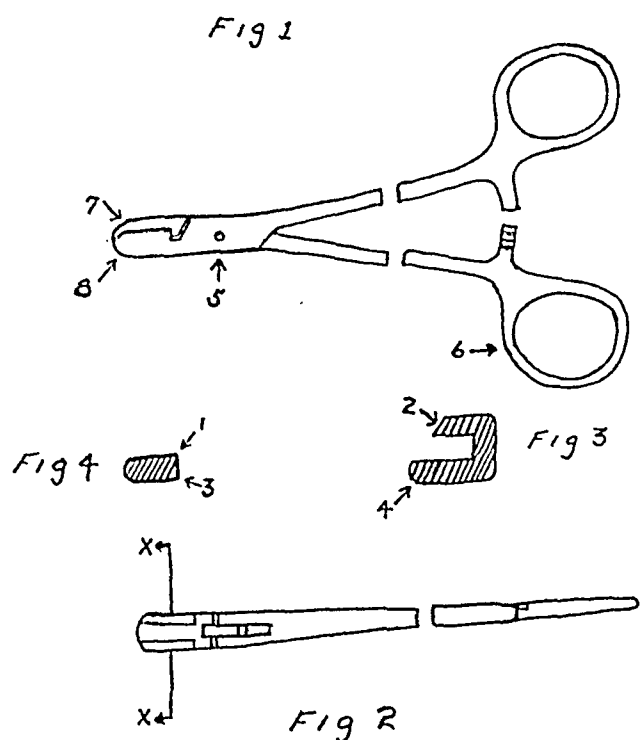


FIG. 1. Side view. FIG. 2. Edge view. FIGS. 3 AND 4. Cross section through Figure 2 at x-x.

from the tie and then to cut off the redundant material with a scissors. This procedure requires two motions, two instruments and frequently the help of the assistant or nurse.

The instrument described herein cuts and clamps the suture with one stroke. This eliminates one motion, one instrument and the help of the assistant. It is suggested that the name Kut-Klamp be used to designate this instrument and we will refer to it as such hereafter.

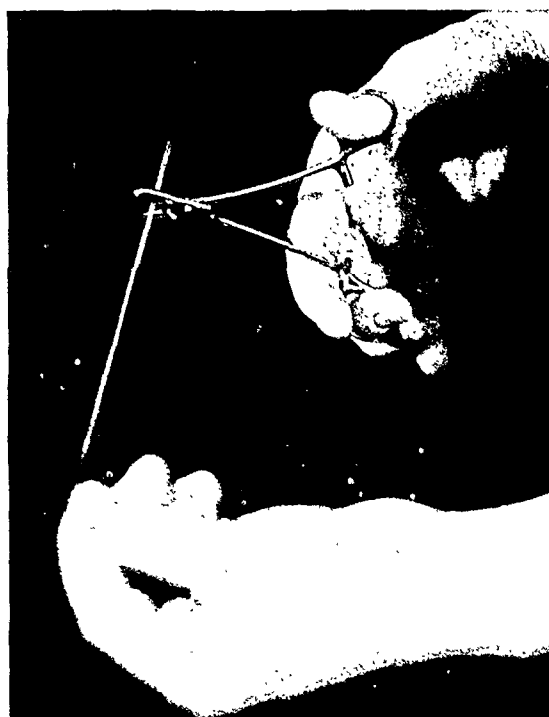


FIG. 5. Before cut.

is 4 inches long and is similar in design to the conventional clamp. From the lock to the tip of the instrument it is 1 inch and in it are the jaws, 7 and 8, which embody the innovation.

The two jaws, 7 and 8, may be described by referring to them as male and female. As shown in Figure 3 the female jaw is U-shaped in cross section and has a groove extending lengthwise along the jaw. The male jaw (Fig. 4) fits this groove closely. As shown, one side of the male jaw, 1, is ground and sharpened to provide a cutting

\*From the Gynecological Division of Harlem Hospital in New York City, Dr. Henry C. Falk, Director,

edge, and the corresponding side of the female jaw, 2, has been sharpened to provide a cutting blade. They thus function as

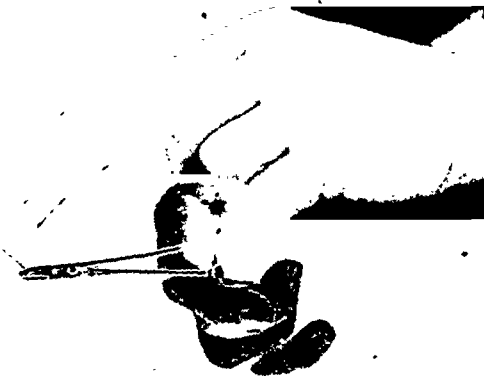


FIG. 6. After cut.

shears. The other side of the male jaw, 3, has been left blunt, thus providing for a

clamping action when it meets, 4, also blunt.

It will be noted in Figure 3 that the clamping side, 4, of the female jaw is higher than the cutting edge, 2. Thus the suture is caught and clamped before it is cut.

To indicate the cutting side the lock pin is made with a knob-like projection, 5, on this side.

In using the Kut-Klamp the surgeon picks up the instrument, the knob-like projection, 5, indicating to him the cutting side. The suture is grabbed in the Kut-Klamp and the jaws closed. With this one stroke the suture is clamped and cut, and the conventional latch arrangement retains the jaws in the closed position.

This procedure is distinctly illustrated in the accompanying photographs (Figs. 5 and 6).

This instrument is at present being used at the French and Harlem Hospitals in New York City.





[From Fernelius' *Universa Medicina*; Geneva, 1679.]

# BOOKSHELF BROWSING

## THE LIFE AND TIMES OF THOMAS SYDENHAM\*

N. P. RATHBUN, M.D.

Chief Attending Urologist, Brooklyn Hospital

BROOKLYN, N. Y.

IN 1924 medical men in all parts of the world foregathered in their various meeting places and celebrated the tercentenary of the birth of Thomas Sydenham. On that occasion many distinguished men delivered eulogies upon his life and work and accomplishments; tablets and busts, dedicated to his memory, were unveiled and hospitals were named for him and endowed in his name. This was really in a way a very remarkable phenomenon, not alone because of the fact that no one more than he, himself, or, for that matter, any of his contemporaries, would have been more surprised at such an action, but particularly remarkable in that this thing could not possibly have occurred at an earlier date. As I sense it, it seems to be the fate of most ordinary mortals to have a proper appreciation of their outstanding virtues delayed until immediately after their demise. Such appreciation is usual, perhaps ordinary, short lived and of little note. Sydenham not being an ordinary mortal presents a very different picture.

He grew more in stature during the sixth half century following his birth than during any other period. It required the lapse of nearly three hundred years before the

profession came to realize the importance and significance of his contributions to the progress of medicine. Surely such a man warrants our consideration.

We can perhaps get a better picture of Sydenham if we pause for just a moment and consider very briefly the times immediately preceding his birth and during which he lived. These times were crowded with important events and perhaps had greater influence upon succeeding events than any other similar period of history.

Elizabeth had completed her long and notable reign. Spain had been eliminated, apparently forever, as an important world power. Literary excellence had attained an all time high water mark in England and other parts of Europe, notably France. Shakespeare had wine and dined, perhaps wisely, undoubtedly at times too well with his cronies Marlowe, Ben Johnson and others. Between bowls of wine, a good story and perhaps a song or two he had scribbled bits of verse on theatre programs and other odds and ends of paper and these fragments, without further editing or embellishment were the sonnets which we read and admire today. In a brief period of less than twenty years he had written his

\* Read before a meeting of the Brooklyn Hospital Staff, January, 1936.



immortal plays and retired to Stratford to enjoy the last few years of his relatively short life as a retired gentleman of means. A little later Milton was pondering over his great epic poem and finally, out of the total darkness of his own life, dictated *Paradise Lost* to his devoted daughters. Locke was preparing to write his philosophical essays, Pepys was writing his diary and many other writers were contributing their quota to the classics of today.

The Holy See at Rome, after years of meddling in European politics had, in the opinion of many, become corrupt. Luther in Germany and later John Knox in Scotland had dared to rise up and not only challenge the infallibility of the Pope but had further dared to challenge his interpretation of the Scripture and to refute the theological and ritualistic dogmas which had carried down through the ages. The peace of Europe was being constantly threatened by differences of religious opinion. Witches were burned at the stake and wholesale massacres were not uncommon. People took their religion seriously in those days. They spent their lifetime savings for the erection of mighty cathedrals, whose architectural beauty and magnificence have never been surpassed; they were willing and they did shed their blood for their beliefs. May I say in passing that both the proponents and the protestants have, since those olden days, come staggering down through the centuries. They have long since ceased to murder one another but each in their own way have, in my humble opinion, drifted and are continuing to drift further and further away from the very simple but very profound philosophy propounded nineteen hundred years ago by the carpenter of Nazareth.

Elizabeth was succeeded by James, the son of her cousin, the ill-fated Mary, Queen of Scots. His elevation to the throne firmly united the Kingdoms of England and Scotland and might perhaps be interpreted as the beginning of Great Britain. His one other claim to fame lies in the fact that his name is attached to the Bible as we know

it today. His relatively short reign was followed by that of his son, Charles I. Charles undertook to establish himself as an absolute monarch and lost his head in the effort. There followed the interregnum of Cromwell, whose cause was staunchly supported by Sydenham. Persecutions in the name of religion continued and were very definitely a factor in speeding up the colonization of our own country. The colonies were becoming organized; John Harvard was starting his little school in Cambridge and the decimation and eventual annihilation of the American Indian was getting under way.

London had become a great metropolis with a population of half a million. Culture and education among the gentry had reached a high peak. Latin was an outstanding feature in the curricula of all schools and colleges and no gentleman's education was considered complete until he had acquired a knowledge of this language which would enable him to read and to write it quite as fluently as his native tongue. These were the times and this the atmosphere into which Sydenham was born and through which he lived. His life span carried through the periods of Charles I, Cromwell and Charles II, who was recalled to the throne from his exile in France, following the decline of Cromwell. Compared to the turbulent times immediately preceding, the reign of Charles II was relatively peaceful and uneventful.

While all of these tremendously important events were transpiring in the world at large, events of equal importance had occurred and were occurring in the development of medicine and surgery.

After the lapse of many centuries, during which the teachings of Galen and the Arabian school had been blindly followed and few if any had thought of questioning them, Vesalius had dared to challenge their authority. He had made his careful painstaking dissections, created the science of anatomy and had written one of the great, perhaps the greatest medical classic of all time. Other brilliant anatomists, Sylvius,

Fallopian, Willis, Steno and many others, getting their inspiration from the great master, had supplemented his work.

Ambrose Paré had rescued surgery from the hands of the barber and elevated it to the rank of a science and an art.

Jansen had experimented with the simple lens of Roger Bacon, DaVinci and Gallileo and produced a microscope. With its aid Malpighi had delved into the ultimate stricture of the body tissue and established histology as a science. Von Leeuwenhoek further improved the microscope and finally produced an instrument not unlike what we use today. He saw and described and made drawings of bacteria and, strange to relate, this man, the janitor of a district court house, not only did all of this but he was the first man who actually saw the blood cells coursing through the capillaries. This phenomenon he described accurately and thus provided the one missing link in the epoch making discovery of Harvey reported a few years before. Harvey made his monumental contribution during the early days of Sydenham's life. The circulation of the blood had been suggested many years before by several writers; Aristotle, Galen, DaVinci and others; and Servetus had already written an accurate description of the pulmonary circulation. However to William Harvey belongs the credit of this great and epoch making discovery.

Time will not permit of any further elaboration of this phase of my topic but enough has been said to demonstrate that scientific medicine was getting under way when Sydenham came upon the scene.

However, it is only fair to say also that these data had not been assimilated nor had their significance been sensed even in a small degree. The practice of medicine was still stultified by the traditions of the centuries and the teachings of Galen and his many disciples. It was based in large measure upon a combination of more or less weird conceptions of anatomy and physiology, together with many equally weird superstitions. The left hind leg of a

rabbit killed in a graveyard during a full moon was still a sovereign remedy for many ills.

Sydenham never got away entirely from this atmosphere. He apparently attached little significance to Harvey's contribution, at least he never mentioned either Harvey or his work in his voluminous writings. Of course he must have known about them as he and Harvey were in a sense contemporaries. In fact, for all we know, they may have been neighbors or even personal friends. On the other hand, he was not tethered by tradition. He believed only what he saw himself and made his deductions and conclusions from personal observations made at the bedside. He was undoubtedly the first great clinician since Hippocrates.

Sydenham was born in Dorsetshire in 1624, just four years before Harvey had demonstrated the circulation of the blood. He was the son of a moderately well-to-do and genteel family and his education was planned and carried forward along lines befitting his station in life. He eventually enrolled as a student at Oxford but left shortly after his enrollment to take up arms with Cromwell against the King. During the interregnum he returned to Oxford and graduated with the degree of Bachelor of Medicine. Sometime in his thirties he settled in London, started in practice and at the age of thirty-nine became a Licentiate of The Royal College of Physicians but was never admitted to fellowship in this august body. However his bust occupies a place of honor in front of their building today. He was doubtless little if at all disturbed by this attitude. Such honors had little appeal for him. He said in a letter to a friend, "I have weighed in a nice scrupulous balance whether it is better to serve men or to be praised by them, and I prefer the former." He did, however, receive a doctor's degree from Cambridge when he was fifty-two. Sometime during this period, probably fairly early in his professional career, he spent some time in France working with the great French clinician, Bar-

beirac. The methods, thoughts and activities of these two men had many points in common and they have often been referred to as the French and the British Hippocrates.

A popular conception of the nature of disease during the early days of Sydenham was the chemical one. It was assumed by many that all diseases were due to differing types of fermentation, which produced either an excess of acid or an excess of alkali and that the proper treatment depended entirely upon recognizing upon which side the error lay and administering acids or alkalis accordingly. Of course this seems a bit fanciful and yet we of today talk glibly about acidosis and alkalosis, perhaps with good reason, and yet I wonder what the practitioners of the twenty-third century will think about it.

Sydenham was not particularly interested in the fundamental nature of disease. He was rather interested in a recognition of the symptoms, the course it might be expected to take, its incidence in reference to locality, seasons, climatic conditions, etc., whether or not it was likely to occur as an isolated instance or spread in epidemic form, and methods of relieving symptoms and effecting a cure. He summed up his own conception of disease processes in general in rather a shrewd definition. He said, "Disease is an effort of Nature, striving with all her might to restore the patient by elimination of the morbid matter." In the language of our friend Al Smith, "Think it over." I think it is a pretty good definition even today.

His description of many diseases, smallpox, pulmonary tuberculosis, chorea, gout, malaria, hysteria are classic and well worth reading even today. Chorea still bears his name. He described accurately the quotidian and tertian type of malaria. He demonstrated that hysteria as a symptom complex was not confined to the female sex. He wrote very feelingly of gout since he was a victim himself. He also apparently suffered from urinary lithiasis since he describes frequent attacks of hematuria and gravel. His methods of treating

these symptoms, omitting surgical measures about which he of course knew nothing, was highly intelligent even when judged by the standards of today.

His description of pulmonary tuberculosis or phthisis, as he called it, is well worth quoting. He said,

The cough betrays itself. The phthisis comes on between the ages of eighteen and thirty-five years. The whole body becomes emaciated. There is a troublesome hectic cough, which is increased by taking food and which is distinguished by the quickness of the pulse and the redness of the cheeks. The matter spit up by the cough is bloody or purulent. When burnt, it smells fetid. When thrown into water it sinks. Night sweats supervene. At length the cheeks grow livid, the face pale, the nose sharp. The temples sink, the nails curve inward, the hair falls off and there is a colliquative diarrhea, the forerunner of death.

One could hardly ask for a more vivid description. It shows very keen powers of observation and must have represented many hours of study at the bedside of his patients in their homes. (Remember that, throughout his life he never had a hospital service.) It seems strange that so keen a man did not go one step further and percuss or put his ear to the chest of his patients. Apparently he never did or, if he did he never wrote about it.

During the active period of Sydenham's career, a severe epidemic of bubonic plague spread over London with an enormous loss of life. During most of the time that this epidemic was raging over the city, Sydenham was away in the country. Some of his biographers have criticized him for this apparently cowardly attitude. In his defense we should perhaps consider that after all he was engaged in private practice mostly among the well-to-do, that he had no hospital affiliations and that most of his patients had also fled the city. He did however return before the epidemic was over, saw a few cases and commented very shrewdly upon them, particularly in connection with the manner of spreading. It is rather interesting to note in passing that

various observers of those days suspected the dog and the cat as carriers. They just missed the rat; another one of the many instances in which an important fact has been missed by the narrowest of margins.

Perhaps his greatest contribution to the literature was his work on fevers and fever in general. This work was revolutionary and was not only far ahead of his own times but apparently far ahead of the times of many succeeding generations. He maintained that fever was a wholesome process and was Nature's own method of combating noxious substances in the system. It required the lapse of two hundred and fifty years before the profession could assimilate this simple but important fact. No longer ago than the early years of the present century men were needlessly combating fever with phenacetin, acetanilid and various other so-called febrifuges.

His therapeutic measures were, on the whole, excellent even when judged by present day standards. He was the first man who had the courage to rely occasionally on a course of masterly inactivity and give Nature a chance to effect a cure. He was firmly convinced that no remedies should be applied unless clearly indicated. He stressed the importance of Nature's own remedies, fresh air, sunshine, plenty of water to drink, dietary regulation and other hygienic measures. Particularly in fevers did he advocate fresh air and an abundance of cold water and other cooling drinks. This, too, was revolutionary and again required a lapse of two hundred and fifty years before it was accepted. I well remember when as a youngster I had measles, I was placed in a hot stuffy room, with windows tightly closed and plied with hot nauseating drinks, all for the purpose of bringing out the rash. I would have given anything which I ever hoped to possess for one drink of cold water. I believe that was the standard treatment of those days. Of course I had never heard of Sydenham then. I am equally certain that my attending physician had never heard of him either.

Of course Sydenham did use drugs; even today laudanum is spoken of as Sydenham's tincture. He employed venesection, which was very popular in those days. He even resorted occasionally to ridiculous decoctions containing a multitude of ingredients, one in particular which was said to contain something like eighty ingredients and required three months for its preparation. As I said a little earlier, he never got away entirely from the traditions and superstitions of preceding ages.

As one reflects upon the career and activities of Thomas Sydenham as a practicing physician, I wonder if we, even of today, cannot discern a lesson. Surrounded as we are and perhaps a bit spoiled by an endless list of technical aids, are we not prone to forget that we too have eyes and ears and fingers, perhaps a bit of common sense and in the course of time, a modicum of experience?

While, of course, there is no reason in the world why all or any of our modern aids to diagnosis should be thrown out of the window (three letters at a time or any other way) I do think that on many occasions we might, to the mutual advantage of our patients and ourselves, invoke much more freely than we do the very simple armamentarium which served Sydenham so well.

Sydenham had very few pupils. Perhaps the most notable among those few was Dover, of Dover's powder fame. In this connection, remember again that he had no hospital affiliations and therefore was not geared for teaching. What teaching he did was largely through the medium of his writing and he wrote extensively, always in Latin, according to the custom of scholars of his times.

His papers and books were published in practically all of the countries in Europe and were eventually translated into English, gathered in one volume and published in America. Every bit of his writings were based absolutely and entirely on his own personal clinical observations. They were concise, to the point, carried no excess

verbiage and never referred to previous authorities. Perhaps he erred a bit in that. On the other hand, I wonder if this, too, does not provide a thought for the writers of the present day. It would seem that no paper of today is complete without two or three pages of bibliography. Of course this is perhaps commendable and often essential in certain types of papers and yet I have a feeling that it is a bit overdone. After all, isn't the best paper the one that contains some one single original thought, briefly and concisely presented? One of the greatest scientific papers of all time, Einstein's original paper, occupied half a page in a scientific journal.

One might ramble on almost indefinitely discussing many other phases of this interesting period and the influence which

Sydenham had upon it. However, I fear that I am exceeding my time allowance.

May I conclude by saying that, in my opinion, Sydenham does not quite belong in the very small group of intellectual giants who grace the pages of medical history. He does not, either by his attainments, by his accomplishments or by his influence upon the subsequent course of medical and surgical progress, quite measure up to the stature of Hippocrates, Galen, his own contemporary Harvey, John Hunter, or in more modern times, Virchow and Pasteur, and a few others who might be included. He does, however, occupy a distinguished position in a slightly larger group and his name will for all time be accorded a place of honor in the blue book of medical and surgical history.



## BOOK REVIEWS

RECENT ADVANCES IN LARYNGOLOGY AND OTOTOLOGY. By R. Scott Stevenson. Philadelphia, P. Blakiston's Son & Co., Inc.

This volume on recent advances in otolaryngology is very well conceived and put together by the author. In his preface he recommends the volume to students and house surgeons in otolaryngology and very timidly suggests that the volume also might be of value to more advanced practitioners in the specialty. In the opinion of the reviewer the volume most certainly is of great advantage to the practitioner of otolaryngology because it gives, in concise and clear language, a review of the advances made in each section of the specialty over a period of the last five years. The advances are in many places very critically reviewed by the author in the light of his own experience, and, if for no other reason than these critical reviews the volume would be of great interest to the average practitioner. There is also in the references at the end of each chapter something which is of very great advantage to the specialist who wishes to carry his study further by a personal review of the literature studied by the author. From the reviewer's point of view this is also a very valuable and very important contribution to the education of the busy specialist.

This book is also commended for study to those American students of otolaryngology who are preparing themselves for the examination by the American Board of Otolaryngology, because it gives to them in a very small volume many of the pathological and physiological studies, searching for which they would have to spend a great deal of time and energy studying the recent periodicals.

It is hoped that when the next five years has elapsed another volume written in the same style will be available.

AURAL THERAPY IN RELATION TO DEAFNESS. By Prof. D. F. Fraser-Harris. London, Sterling Medical Publishing Co.

This is a small brochure apparently written for the general practitioner and the laity

bringing forth the uses of the audiometer in the study of deafness and attempting to describe in simple terms some of the types of deafness in relationship to audiometer curves. The reviewer can see no reason for the chapter on treatment with the author's thermocatheter. The few lines on the use of hearing aids perhaps could have been done with greater thoroughness.

TEXTBOOK OF GENERAL SURGERY. By Warren H. Cole, M.D., F.A.C.S. and Robert Elman, M.D. New York, D. Appleton-Century Company, 1936. Price \$10.

We learn that this volume of 1031 pages is a direct outgrowth of a formal recitation and lecture course in surgery given by the authors to the third year class at the Washington University School of Medicine during the past eight years. In the Preface we read, "Most of the text, indeed, represents the teaching material resulting from the use of mimeographed assignments which have been repeatedly revised and corrected during the past three years. . . . The text also includes the more advanced details, which fourth year students are expected to know before graduation. . . . The material included should also suffice for the every day use of the general practitioner." The authors also strike a pleasing note when they say, "If more extensive details of a particular surgical disease are desired, a system of Surgery will be required; it is obviously inappropriate to include a complete discussion of one or more diseases without doing so for all, and this is impossible in a single volume work."

With this in mind, the authors have eliminated detailed consideration of the specialties, ophthalmology, otology and rhinology. On the other hand, they have stressed such allied specialties as genitourinary surgery and gynecology. Certain details of neurosurgery, especially head injuries, have been included.

The authors have stressed the subject matter from a physiological angle, for, in this way the clinical features will be under-

stood better. More detail of case histories in the legends under the illustration wherever possible has been the rule.

The chapter on the emergency prostrate patient, which deals more or less with the unconscious individual should prove of value to the interne, general practitioner and young surgeon. There is a tendency to insist that a textbook is mainly of value to an interne or the young man just beginning surgery. It is our opinion that many middle aged and past middle aged men, and many more or less well known workers in the surgical field may spend no inconsiderable time with modern textbooks relating to their sphere of work. Therefore, this volume being exceptionally good, we suggest to medical teachers of surgery to hint to their students that they might do well, if possible, to own copies.

There are 559 figures, a comprehensive Bibliography at the conclusion of each chapter, and an Index.

**THE EYE AND ITS DISEASES.** By 82 International Authorities. Edited by Conrad Berens, M.D., Ophthalmic Surgeon, Pathologist and Director of Research, New York Eye and Ear Infirmary; 1254 pages with 436 illustrations, some in colors. Philadelphia and London, W. B. Saunders Company, 1936. Cloth, Price \$12.00 net.

This textbook of ophthalmology, edited by Dr. Berens, is an excellent, authoritative book and a valuable addition to the literature of the speciality. Dr. Berens feels that ophthalmology, in view of the constant increase in our knowledge of the eye, has reached the stage where it is beyond the power of one individual to write authoritatively on all its varied phases; and because of this the ideal text should consist of the expert knowledge of many oculists, each writing of the subject in which he is an acknowledged authority. With this in mind, Dr. Berens has searched the United States, Canada, England and the Continent for contributions to this book and requested opinions on their particular assignment from those he thinks best qualified. While many will feel that this is carrying specialization in medicine too far, the results in this book speak against such a conviction, because in the not too well supplied field of

English ophthalmological textbooks, this is one of the best.

The subject of ophthalmology is covered very thoroughly beginning with anatomy and including physiology, bacteriology, refraction, diseases of the eye and surgery; and there are also interesting chapters on hygiene, immunology, medical jurisprudence, pathological and bacteriological technique. It is a great compliment to the editor that he has been able to obtain the collaboration of such well known names in ophthalmology.

There are some defects in the book, because, as would be expected, each individual contribution represents the opinionated conclusions of its author and because of human frailties, known and accepted modes of therapy are often completely disregarded or disparaged, and this of necessity is something which should not happen in a book which endeavors to cover adequately, authoritatively and completely the subject of ophthalmology.

In view of the general excellence of the book it seems picayune to mention any such defects. As seems to happen in all textbooks, the authors are often reluctant to omit beliefs which have become traditional and are carried from text to text as a matter of habit, and we could disperse with many of them. Also accepted forms of medical and surgery therapy are often not mentioned or are lightly dismissed as of no value and those who acquire their ophthalmological information from this book will be ignorant of many definitely valuable therapeutic procedures. This should not be considered as a too severe condemnation of the book, for it is usually so good that one would like to see it even better.

Despite the great number (82) of contributors, the editor has so arranged the subject matter and the varied styles of writing, that one would suspect the book to be the work of one author. The arrangement of the subject matter, the illustrations and the type used, and the index are excellent. The book is recommended to ophthalmologists and those medical men who wish a book which brings ophthalmology up to date with current knowledge.

**A TEXTBOOK OF SURGERY.** By John Homans, M.D. Compiled from lectures and other writings of members of the Surgical Department of the Harvard Medical School. Fourth Edition. With a special

bibliographical index and with illustrations by Willard C. Shepard. Springfield, Ill., Charles C. Thomas, 1936. Price \$8. postpaid.

The first edition of this work appeared in 1931, the second in the following year, the third in 1935, and now a year later, a fourth edition is offered to the profession. Under the editorship of Dr. Homans who made the volume possible are, Arthur W. Allen, David Cheever, Edward D. Churchill, Harvey Cushing, Robert B. Greenough, Gilbert Horrax, Daniel Fiske Jones, William E. Ladd, George A. Leland, Howard A. Lothrop, Richard H. Miller, Edward H. Nichols, Robert B. Osgood, Charles Allen Porter, Tracy J. Putnam, Lyman G. Richards, Edward P. Richardson, Channing C. Simmons, J. Herbert Waite, Wyman Whittemore, and Philip D. Wilson. This work not only represents collection of outstanding authors, but it is a volume whose contents more than lives up to the claims made for it.

In this edition has been added a chapter on "Amputations and Plastics," old material has been replaced with new (the stale with the fresh), and while little has been actually added the pagination is unchanged.

The book is 1267 pages long, and contains 530 figures. The Bibliographical Index is interesting and has been especially well done. Other authors might look this over and add it to their forthcoming books.

The owner of this book will find himself, at times, putting aside the current best-seller in fiction or biography and returning to this Textbook of Surgery, for, it reads more like some human document than a cut and dried book of science.

**DISEASES OF THE CORONARY ARTERIES AND CARDIAC PAIN.** Edited by Robert L. Levy, M.D. Advisory Editorial Committee Alfred E. Cohn, James B. Herrick and Carl J. Wiggers. New York, The Macmillan Company, 1936. Price \$6.00.

During the past two decades great advances have been made in the study of the affections of the coronary arteries and of cardiac pain. Because of these advances in the knowledge of these conditions many once doomed to a speedy death are, today, offered hope of added years of usefulness.

Therefore, it is timely that this book is presented to the medical profession. Naturally, as this subject involves so many aspects, no one man could write a book on the subject and do all aspects justice. The editor, aided by an advisory editorial committee, selected fourteen men specially equipped to write on their given topics. These contributors are, Claude S. Beck, Herrman L. Blumgart, Alfred E. Cohn, Louis I. Dublin, James B. Herrick, William J. Kerr, Fred M. Smith, William C. Von Glahn, Joseph T. Wearn, James C. White, Paul D. White, Carl J. Wiggers and Frank N. Wilson.

The Preface is by Robert L. Levy, the Introduction by Alfred E. Cohn, and the Historical Note by James B. Herrick.

Part 1 deals with The Coronary Circulation (four chapters are devoted to this); Part 2 deals with Cardiac Pain (two chapters); Part 3 with Clinical Features of Diseases of the Coronary Arteries and Cardiac Pain (six chapters); Part 4 with Medical Treatment of Diseases of the Coronary Arteries and Cardiac Pain (two chapters); and Part 5 deals with Surgical Treatment of Diseases of the Coronary Arteries and Cardiac Pain (three chapters).

This excellent book of 445 pages, with an ample Bibliography at the end of each chapter, with a thorough Index, profusely illustrated, fills a needed want in the present day literature on this vital topic.

**TEXTBOOK OF SURGICAL NURSING.** By Manelva Wylie Keller, B.S., R.N. Third Edition. Completely revised and reset. New York, The Macmillan Company, 1936. Price \$3.

Physicians on hospital staffs who instruct nurses know this book as it is a standard work. Because this work is so widely known and used in so many institutions where nursing is taught it is unnecessary to go into detail regarding the contents.

In this third edition, the book has been rewritten in parts, revised throughout, and reset.

It is illustrated and at the end of each chapter is a list of questions on the matter covered in that chapter for student review.

Any physician or head of a hospital nursing school will feel secure in recommending this book as a textbook for student nurses.





# PRACTICAL CLINICAL GYNECOLOGY

HENRY C. FALK, M.D., F.A.C.S.

## FOURTH INSTALLMENT

### CONTENTS

#### *[[ This Issue ]]*

| CHAPTER                                       | VOL. XXXVI | PAGE |
|---|------------|------|
| VI. Retrodisplacements of the Uterus. . . . . |            | 750  |
| VII. Menstruation and Its Disorders. . . . .  |            | 766  |

#### *[[ Previously Issued ]]*

|   | VOL. XXXV  | PAGE |
|---|------------|------|
| I. Examination of the Patient . . . . .   |            | 153  |
| II. Preoperative Hospital Routine; Preparation of the Patient; Post-operative Hospital Routine. . . . . |            | 172  |
| III. Abortion. . . . .  |            | 187  |
| IV. Gonorrheal Infection of the Tubes. . . . .  |            | 629  |
| V. Fibroids. . . . .  | VOL. XXXVI | 559  |

## CHAPTER VI

### RETRODISPLACEMENTS OF THE UTERUS

The normal uterus is a freely movable organ suspended in the pelvis by the coordinated action of its supporting structures which consist of:

1. The uteropelvic ligaments running outward from the supravaginal portion of the cervix to the pelvic fascia in the base of each broad ligament. These ligaments prevent the uterus from undergoing lateral malpositions and also prevent prolapse;
2. The broad ligaments, which steady the uterus in or near the median section of the pelvis;
3. The uterosacral ligaments which pull the cervix backward and upward thereby throwing the fundus forward;
4. The round ligaments, which act as "guy ropes" and to some extent prevent the uterus from falling backward.

In the erect posture the uterus normally lies in a horizontal position with the cervix pointing backward. It is maintained in this position largely by the intra-abdominal pressure which is exerted on the posterior wall of the uterus. When the supporting structures become weakened, the anterior wall of the fundus becomes separated from the bladder and the intestines can then enter the vesicouterine space. This causes the intra-abdominal pressure to be exerted on the anterior wall of the uterus and thus gradually forces the fundus into the cul-de-sac. When the fundus is pushed backward, the cervix is forced forward with a corresponding lengthening of the uterosacral ligaments.

### PATHOLOGY

What are the pathological changes produced in the uterus and ovaries as a result of retrodisplacement?

When the uterus is in a posterior position the broad ligaments become partially twisted and as a result there is an

interference with the return blood supply. This produces chronic congestion of the uterus and occasionally varicosities of the veins in the broad ligament. The retrodisplaced uterus causes a prolapse of the ovaries, which may become painful and enlarged as a result of interference with their circulation. When a postpartum or postabortal uterus is in a posterior position it does not involute properly.

### SYMPTOMS

There is a large group of patients with uncomplicated retroflexion presenting no symptoms whatsoever.

There is another group of patients where the retrodisplacement is associated with other pathology and the symptoms produced by the associated pathology completely mask any symptoms the retroflexion may cause.

Most of the symptoms of the uncomplicated retroflexion are caused by the circulatory changes—dragging sensation, feeling of weight in the pelvis, menorrhagia, backache and leucorrhea. Indefinite reflex symptoms, “loss of pep,” etc., are sometimes attributed to this condition. Sterility may be caused by a retrodisplacement of the uterus due to an angulation of the tubes. Recurrent abortions may result from the impaction of a retroflexed pregnant uterus. Prolapse of the ovary associated with retroflexion is a frequent cause of dyspareunia.

### TREATMENT

Patients with retrodisplacements of the uterus may be classified into three groups:

1. Those who are symptom free, and therefore require no treatment;
2. Those with symptoms, with replaceable retrodisplacements where the judicious use of a properly fitting pessary will relieve or cure the condition;
3. Retrodisplacements requiring relief, but which cannot be cured by nonoperative treatment.

Treatment of the noncomplicated retrodisplaced uterus producing symptoms:

*Prophylaxis.* Prevent the postpartum uterus from tipping backward until the relaxed supports involute sufficiently to hold the uterus forward so that the intra-abdominal pressure

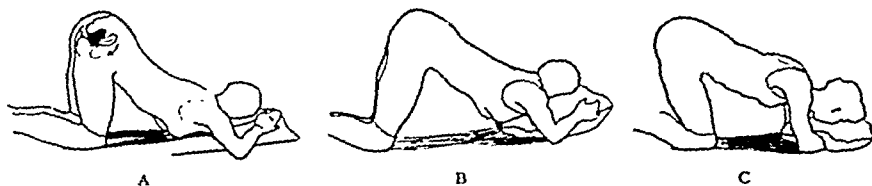


FIG. 81. A. Correct knee chest posture. Chest on couch, bed or floor, knees apart, thighs up and down. After taking posture external parts are drawn open to allow air to enter. It escapes on return to upright posture. B. Incorrect. Chest on pillows, thighs slant away from body. C. Incorrect. Resting on elbows, thighs slant inward toward body.

can be exerted on the posterior surface of the uterus and thus hold it in the normal anterior position. A postpartum uterus will not fall into the cul-de-sac until after the tenth day. Why? Because it is not small enough to drop below the promintory of the sacrum. After the tenth day, patients should be encouraged to lie on their sides or on the abdomen until they present themselves at the obstetrician's office for a check-up examination. If at this time a retrodisplacement is found it should be replaced manually and a pessary of the proper size inserted. The patient should then be instructed in the proper use of the knee-chest position (Fig. 81) to help keep the uterus forward.

When the cervix is drawn forward in doing a curettage the fundus goes backward, therefore, following a curettage the uterus should always be replaced manually in its normal anterior position.

*Replacement of Movable Retroflexion.* The patient should be comfortably placed in the lithotomy position on an examining table. The rectum and bladder should be empty. The fingers of the left hand, well lubricated, should be introduced into the posterior cul-de-sac of the vagina and the uterus pushed upward (Fig. 82). As the uterus rises the fingers of the right hand on the abdomen attempt to catch the posterior wall of the uterus; at the same time the fingers in the vagina shift to the front of the cervix. The anterior lip of the cervix is then forced backward (Fig. 83). As the cervix goes backward the

fundus is grasped by the abdominal hand and brought well forward (Fig. 84). The pessary can then be introduced. Occasionally if the fingers are not long enough a tenaculum is placed

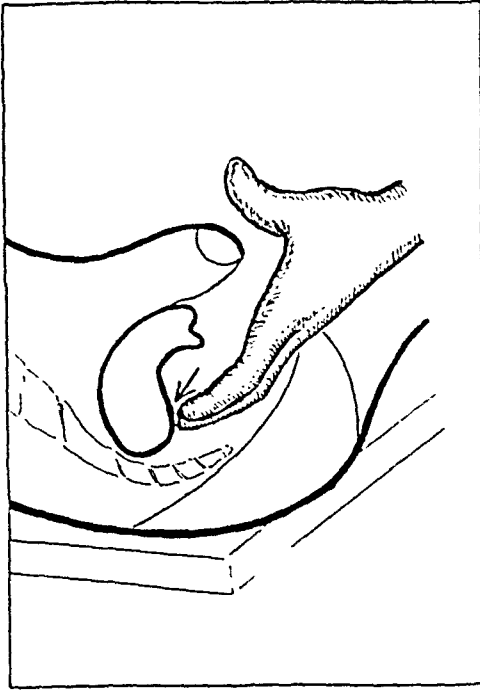


FIG. 82. Two fingers inserted in the vagina or the index finger in the vagina and the middle in the rectum, push the fundus upward in an attempt to dislodge it from the hollow of the sacrum.

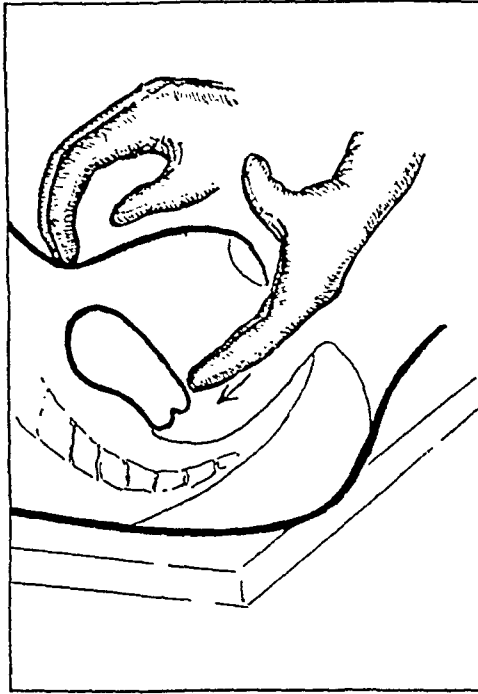


FIG. 83. Two fingers in the vagina pushing the anterior lip of the cervix backward while the fingers of the other hand attempt to grasp the fundus to help bring it forward.

on the anterior lip to give added leverage. There are many other ways to replace a movable retroflexed uterus, two of which will be described.

1. This method is often used. Insert a fairly large pessary into the vagina. Place the patient in the knee-chest position and have her cough several times. This will frequently cause the uterus to fall forward. The large pessary is then removed and the proper size pessary is inserted.

2. Place the patient in the knee-chest position, insert a Sims' speculum and grasp the anterior lip of the cervix with a tenaculum. Draw the anterior lip of the cervix downward and then push it upward and backward. This may cause the fundus

to fall forward. Frequently a sponge on a stick is used instead of a tenaculum.

*Function of the Pessary.* The pessary does not hold the

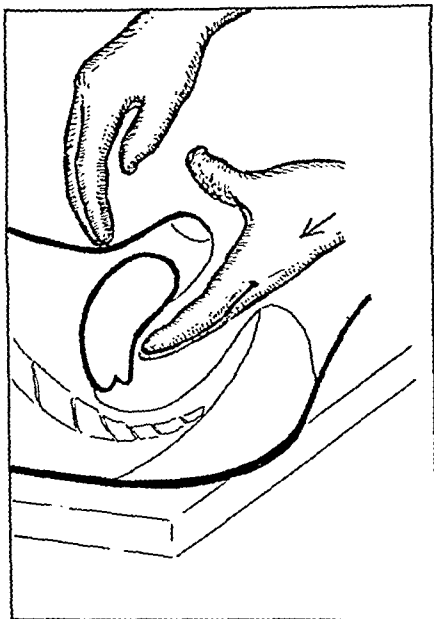


FIG. 84. The vaginal hand forcing the cervix well back while the abdominal hand pushes the fundus forward.

uterus forward, it holds the cervix back so as to allow the normal intra-abdominal dynamics to function. The pessary holds the cervix back by pushing the posterior vaginal vault backward, this throws the fundus forward, thus allowing the intra-abdominal pressure to be exerted on the posterior wall of the uterus.

*Size and Shape of the Pessary.* The following factors govern the size of pessary used. It should be large enough to hold the cervix well back and yet it should not project beyond the introitus. It should not cause undue pressure on any spot in the vagina. It should not be too small so as to move too freely in the vagina. It should cause neither pain nor discomfort. The patient should not be cognizant of its presence.

The shape of the pessary usually used is the Albert Smith or Hodge pessary. All sizes should be kept on hand so that they can be tried until the proper size pessary has been inserted.

*Technique of Inserting the Pessary.* The patient is in the lithotomy position, the pessary is clean and well lubricated. It is held by the anterior end in the fingers of the right hand

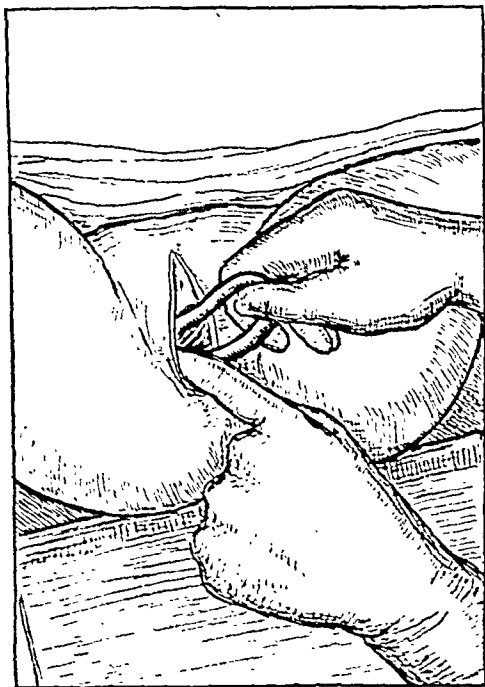


FIG. 85. Index finger of the left hand depressing the perineum. Pessary inserted obliquely by the right hand.

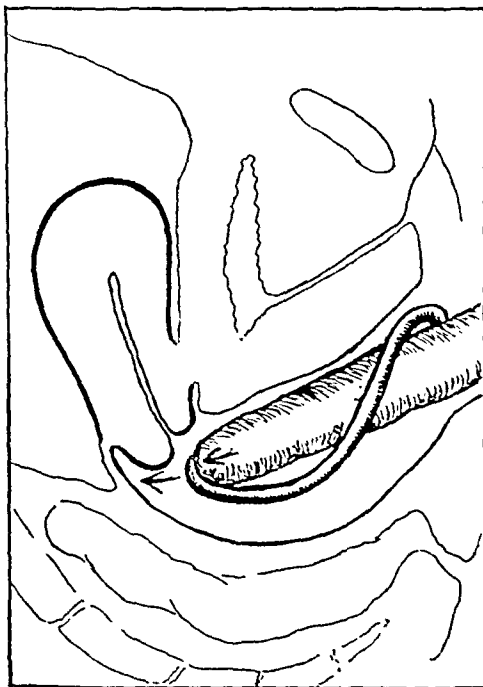


FIG. 86. Index finger on the posterior bar of the pessary depressing it below the posterior lip of the cervix.

with the large concavity slightly upward. The index finger of the left hand is introduced into the vagina and the perineum depressed. The pessary is introduced obliquely (Fig. 85). Any pressure that is exerted should be towards the perineum as the vestibule and urethra are very sensitive. When the pessary has been introduced beyond its widest part it is rotated into the transverse diameter with the large concavity upward. The index finger of the right hand is then placed upon the posterior bar of the pessary (Fig. 86) depressing this bar so as to bring it behind the cervix and to allow the cervix to lie in the opening of the pessary (Fig. 91).

The finger should then be introduced around the pessary to make sure there are no pressure spots and the patient is allowed to walk around the examining room, sit down, strain, etc., to be sure the pessary is comfortable.



Patients are frequently found whose introitus is so small that the rigid pessaries cannot be introduced. Findley has developed a pessary which has given excellent results.

With the advent of episiotomies and more accurate repairs of lacerations of the pelvic floor, the insertion of these rigid pessaries, became more difficult and caused much pain to the patient. The same difficulty was encountered in treating virginal (or nulliparous) cases.

The caliber of the introitus has no proportional relationship to the size of the pessary needed for uterine support. A two-finger, recently repaired introitus will not easily admit a No. 4 or 5 Smith or Hodge pessary. A smaller pessary will often fail to hold the uterus in the anterior position. As a result, both patient and physician were prone to postpone the use of a pessary beyond the time when the best results could be obtained.

To overcome this difficulty, I have devised a modification of the Albert Smith pessary which was described in a previous publication. This instrument is identical with the Albert Smith type except that the end sectors have been replaced by soft solid rubber. These soft rubber segments are seamlessly vulcanized to the lateral arms which are of hard rubber. This arrangement allows the lateral arms to fold together so that any size can be easily introduced through a one-finger introitus. The patient frequently does not realize that the pessary has been inserted as it provokes no more sensation than that of one finger. This instrument unfolds automatically in the vagina and because of its longitudinal rigidity effectually pushes the posterior fornix upwards and backwards. This puts the uterosacral ligaments on tension and pulls the cervix upwards and backwards thus holding the uterus in anterior position.

To further simplify the application of this pessary, I fold it in the manner shown in the illustrations. As shown in Figure 87 the device is held in the position which it is to take in the vagina, the upper and larger end being held by the fingers and thumb of the left hand and the lower, or smaller end, in the same manner by the right hand. In Figure 88, the lateral arms of the pessary are being folded together by exerting pressure downwards by the forefingers and upwards by the thumbs and middle fingers. This is continued until the lateral arms meet. In Figure 89, a firm grip of the thumb and fingers of the right hand on the lower end of the pessary keeps the lateral arms together and thus the pessary has had its curve reversed. In Figure 90, the introduction is plainly shown. The reverse curve causes the upper end of the pessary to follow the posterior wall of the vagina to the posterior fornix. In Figure 91, the pessary has been released, has unfolded, and the upper end of the pessary has automatically taken its place posteriorly to the cervix.

It will be seen that this method obviates any necessity for re-adjustment after insertion. The pessary is easily removed by physician or patient by hooking one finger into the lower end. The pessary will fold itself as with-

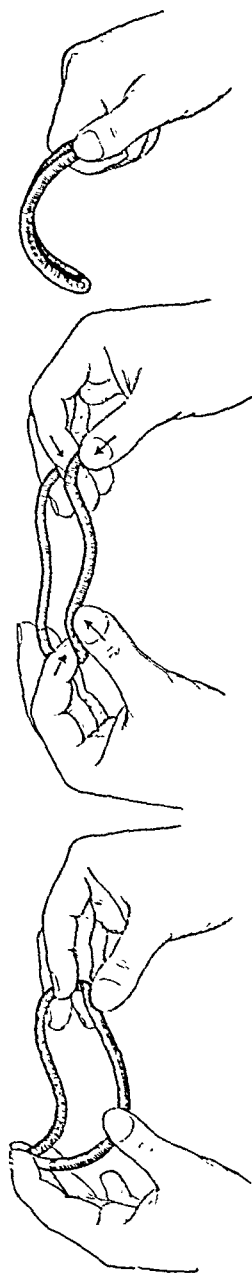


FIG. 87.  
FIGS. 87, 88, AND 89. Method of bending pessary. (Findley, W. M. *Am. Jour. Surg.*, 33: 551, 1936.)

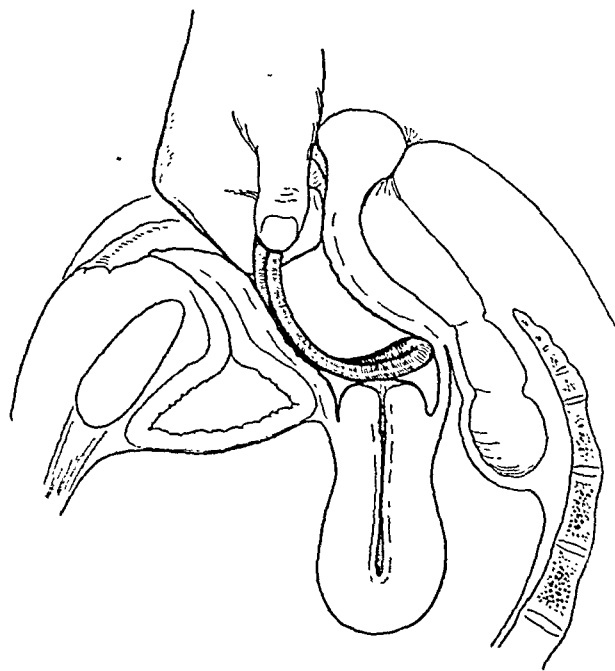


FIG. 90. Pessary inserted in vagina before release. (Findley, W. M. *Am. Jour. Surg.*, 33: 551, 1936.)

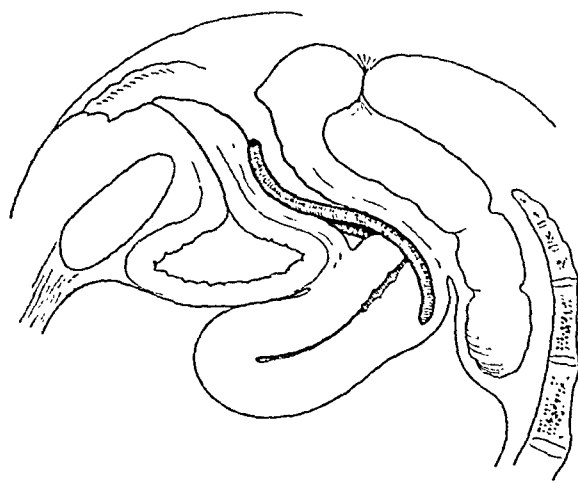


FIG. 91. Pessary in situ. (Findley, W. M. *Am. Jour. Surg.*, 33: 551, 1936.)

drawn. The discomfort and difficulties of application are thus largely eliminated. Various sizes may be tried to obtain proper fit.\*

\* FINDLEY, WM. M. Non-surgical treatment of retrodisplacement of the uterus. *Am. Jour., Surg.* 33: 546, 552, 1936.

Following the insertion of the pessary, the patient should return in one week for an examination. If she has had no discomfort and the uterus is well anterior the patient should be instructed to return every four to six weeks, preferably after a menstrual period. The pessary is then removed and cleaned, the vagina inspected for any pressure spots and the pessary reinserted.

A pessary as a rule should be worn for six months. Following the removal of the pessary, the patient is told to return in one week for a reexamination. If the uterus retains its normal position, she is to return in one month; if then it is still anterior, she is discharged. Following the removal of the pessary, the knee-chest position is continued night and morning and the patient is advised to sleep on her side or on her abdomen.

If on reexamination the uterus has again fallen back, it is replaced and the pessary is reinserted. If at the end of another six months, removal of the pessary again causes the uterus to fall back, producing symptoms, operation is advised.

When operative treatment is indicated, what procedures shall be used?

Examination of a standard operative gynecological textbook shows eighty pages devoted to a discussion of the various operations for retrodisplacement. The purpose of the operative treatment should be to restore the uterus to its normal physiological and anatomical conditions. The procedure which has given the best results at Harlem Hospital has been the Webster-Baldy operation combined with suspension of the ovaries and shortening of the uterosacral ligaments. In order to eliminate technical difficulties the uterosacral shortening is done before the Webster-Baldy operation.

*Technique of Shortening the Uterosacral Ligaments.* Any procedure for the shortening of the uterosacral ligaments must fulfill three demands:

1. It must keep the cervix well back in the hollow of the sacrum;
2. It must hold it there fairly permanently;

3. As the uterosacral shortening is only one of several operative procedures to be performed on the patient, it must not be time consuming.



FIG. 92. Placing of the sutures in shortening the uterosacral ligaments. Each is tied only after both have been placed. (Holden, *F. C. Am. Jour. Surg.*, 33: 553-557, 1936.)

Good anesthesia, the Trendelenburg position and an ample incision which extends down to the symphysis so as to secure good exposure, are absolutely essential for shortening the uterosacral ligaments.

Step 1. The intestines are walled off with the three pad technique.

Step 2. The uterus is pushed well forward, anteфлекed, the



FIG. 93. The sutures shortening the uterosacral ligaments have been passed around the left ligament at *e*; a sharp pointed clamp has been introduced under the ovarian ligament and tube, *c*, and the traction suture, *d*, of the left round ligament grasped. The round ligament is then pulled through the opening made as is shown on the right side, *n*. (Holden, F. C. *Am. Jour. Surg.*, 33: 553-557, 1936.)

posterior wall of the uterus is grasped at the level of the internal os with a tenaculum and the cervix is drawn upward, making the uterosacral ligaments prominent. A continuous heavy silk suture on a curved Mayo needle is inserted from behind forward (Fig. 92) up to and including a bite in the posterior lip of the

cervix. This is inserted on both sides before being tied (Fig. 93A).<sup>\*</sup> Both sutures are tied.

This procedure shortens the uterosacral ligaments from before backward thereby drawing the cervix well into the hollow of the sacrum. By using a nonabsorbable suture material, such as silk, the permanency of the shortening is assured.

The uterosacral shortening is then followed by the Webster-Baldy operation which seems to observe the basic anatomic as well as physiologic (intra-abdominal pressure) factors.

Step 1. A traction stitch (Fig. 93D) is passed under the round ligament at the junction of its middle and outer third and a clamp is applied to the suture.

Step 2. The ovarian ligament is grasped with an Allis clamp and a sharp pointed curved clamp is introduced under this ligament and under the tube (Fig. 93C) so as to emerge in the angle between the tube and the round ligament; here it grasps the traction stitch (Fig. 93E, C, D) and draws it backward thus pulling the round ligament under the tube and the ovarian ligament and through the opening (Fig. 93B).

Step 3. The same procedure is carried out on the other round ligament.

Step 4. The round ligaments are sutured to the posterior wall of the uterus with four or five interrupted fine silk sutures using a fine curved needle (Fig. 94B).

Step 5. Suspension of the ovaries. The ovarian ligament is grasped with an Allis clamp and drawn laterally as far as possible (Fig. 94D). The distal end of the round ligament (Fig. 94C) is grasped with an Allis clamp and drawn medially. A silk suture (Fig. 94E) is passed through the round ligament as far laterally as possible and through the ovary close to the origin of its suspensory ligament and tied (Fig. 94E and F). The same procedure is carried out on the other side.

Step 6. The abdomen is closed in the usual manner.

Failure following the Webster-Baldy operation may be due to one of several causes:

<sup>\*</sup> HOLDEN, FRED. C. Surgical treatment of retrodisplacement of the uterus. *Am. Jour. Surg.* 33: 553-557, 1936.

1. *Retroflexion over the Round Ligaments.* If the round ligaments are sutured to the posterior aspect of the fundus at too low a level, the fundus may retroflex over these sutured



FIG. 94. The round ligaments have been sutured to the posterior aspect of the uterus at a level just below the insertion of the ovarian ligaments, *aa*. The ovarian ligament is grasped with an Allis clamp and drawn laterally, *b*. The distal end of the round ligament is grasped with an Allis clamp and drawn medially, *c*. A silk suture is passed through the round ligament as far laterally as possible and through the ovary close to the origin of its suspensory ligament, *e*, and tied, *f*. (Holden, F. C. *Am. Jour. Surg.*, 33: 553-557, 1936.)

round ligaments. The round ligaments should be sutured to the posterior wall of the uterus at a point which is on a level or just below the insertion of the uteroovarian ligaments. This is above the centre of the gravity of the fundus and will tend to hold the fundus forward.

2. *Recurrent Retrodisplacement.* This may be due to one of three causes:

A. *The Use of Absorbable Suture Material.* The catgut may absorb and no union take place between the round ligaments and the posterior wall of the uterus. This allows the ligaments to slip back to their former position with a recurrence of the retrodisplacement. Nonabsorbable suture material should be used throughout.

B. *Allowing the Cervix to Remain Forward.* Some of the retrodisplacements recur because the cervix is allowed to remain anteriorly after the fundus has been brought forward by the Webster-Baldy operation. Shortening of the uterosacral ligaments according to the technique described will hold the cervix well back in the hollow of the sacrum. This is an important additional factor in securing satisfactory results. In studying the failures in a series of operations, it was observed that recurrences were found in those patients who on discharge did not have the cervix well back in good anatomical position.

C. *Non-repair of Relaxed Vagina.* Laceration of the pelvic diaphragm and relaxation of the vaginal outlet will allow the uterus to fall backward again after operation as well as after removal of a pessary. In order to restore proper anatomical relationship it is of the utmost importance that the anterior and posterior vaginal walls, if relaxed, should be repaired. This will help maintain the uterus in its anterior position.

3. *Numerous painful adhesions between intestines, sigmoid, omentum and posterior wall of the uterus* are sometimes found. These can be prevented by causing a minimum of trauma to the tissues. The round ligaments are held by catgut "guy ropes" (Fig. 93B and E) and they should not be crushed with a clamp. The round ligaments are sutured to the posterior wall of the uterus using fine curved needles (Ferguson needles size 2, round point, half curved) and fine silk.

4. *Postoperative Pain Due to Tender Prolapsed Ovaries or to Ovaries Which Have Become Adherent to Each Other in the Midline.* The Webster-Baldy operation is the only operation for retroversion which at the same time elevates the ovaries



and tubes. One finds only too often that it is the prolapsed ovary which has been giving the symptoms rather than the retroversion. Simple elevation of the uterus in certain cases will not suspend the ovaries owing to long uteroovarian ligaments. This is corrected by drawing the round ligaments backward just below the uteroovarian ligament (Fig. 93B and C). Although the ovaries will thereby be drawn upward, it will not prevent them from coming in contact with each other. To prevent this, the distal end of each round ligament of the uterus is grasped with an Allis clamp and drawn laterally (Fig. 94C and D). When the round ligament has been drawn as far medially as possible, a silk suture is passed through the round ligament and through the ovary close to the origin of its suspensory ligament (Fig. 94E). In this way the round ligaments exert a constant pull on the ovaries and keep them well suspended and separated from each other (Fig. 94E and F).

**Axiom:** One learns not by one's successes, but by a critical and impartial analysis of failures. Careful attention to each detail is frequently the factor which will make the difference between failure or success.

Question: Should the pessary be boiled for sterilization?

Answer: No; a boiled pessary is always round; boiling a hard rubber pessary should only be done if you wish to change its shape.

Question: How can you make slight changes in the shape of the pessary?

Answer: Cover the pessary with vaseline and heat the part to be molded over an alcohol flame until it is malleable, then bend the part to the desired shape. The vaseline keeps the hard rubber from burning.

Question: What is the effect of pregnancy on the Webster-Baldy operation?

Answer: When the operation has been performed as described there should be no recurrence of the retrodisplacement even after pregnancy.

Question: What should be done if the pessary causes a pressure sore in the vagina?

Answer: Heat the pessary as described and bend the particular spot in such a way as to remove the undue pressure. The red spot in the vagina should be "touched up" with 10 per cent silver nitrate or pure pyroligneous acid.

Question: How is a pessary cleaned?

Answer: It is placed in a basin of cold lysol solution and scrubbed with a brush following which it is washed in cold water.

## CHAPTER VII

### MENSTRUATION AND ITS DISORDERS

A study of the histories of any large series of gynecological cases would show that deviation from the normal menstrual cycle is one of the most frequent complaints presented for treatment. The endometrium is the background of normal and abnormal menstruation. In order to understand the various types of bleeding properly it is absolutely essential to have a clear conception of (1) the normal histological changes that the endometrium undergoes and (2) the glandular interrelationship which is responsible for these changes.

The normal endometrium undergoes a regular cycle of histological changes every twenty-eight days. This cycle may be represented by the circumference of a circle which is divided into 28 equal parts representing the days. To study any regularly repeating cycle it is necessary to begin at some fixed point. The first day of menstruation is the only fixed point in the entire menstrual cycle. A woman always knows when she begins to menstruate; she may not know the exact time when she stops, but she always does know the first moment she starts. Although the first day of menstruation is used as the fixed point, the beginning, it must be recognized as a fact, that menstruation proper is the end of the normal physiological cycle and not its beginning.

In the normal 28 days cycle a woman menstruates for four days. The six-day period just prior to menstruation is called premenstrual, the six days just after menstruation, postmenstrual and the twelve days in between, the interval period (Fig. 95). This division is purely arbitrary and is used as an aid for study.

There are two common misconceptions with regard to the endometrium that must be corrected:

The endometrium is not a true mucous membrane as it has no submucosa. If it had a submucosa, with every curettage

and with every delivery the entire endometrium would be lost. Nothing would be left from which the new endometrium could regenerate.

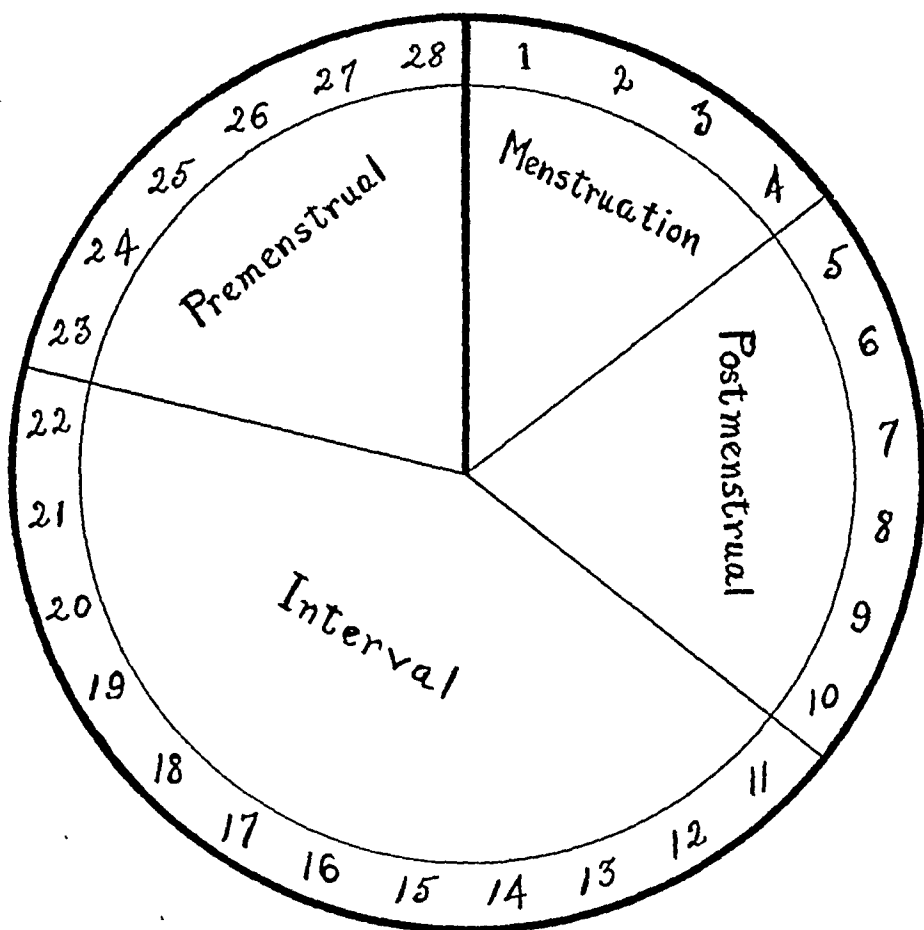


FIG. 95. Menstrual cycle arbitrarily divided into four periods.

The second misconception is that there is a resting stage or period in the endometrial cycle. This is not true. There is no resting period. The endometrium is an ever-changing structure. It may not change in its entirety every day, but there is some change in some part of the endometrium daily.

**PREMENSTRUAL ENDOMETRIUM.** This is the most complex form the endometrium assumes. Grossly, it is composed of glands and stroma. The glands can be divided roughly from their general appearance into three parts: the mouth of the gland (Fig. 96-1), the tortuous part of the gland, (Fig. 96-2), and the inactive fundus (Fig. 96-3).

MOUTH OF THE GLAND or compact layer of the endometrium.

The epithelium lining the cavity of the uterus is a ciliated high columnar epithelium having a central nucleus and a granu-

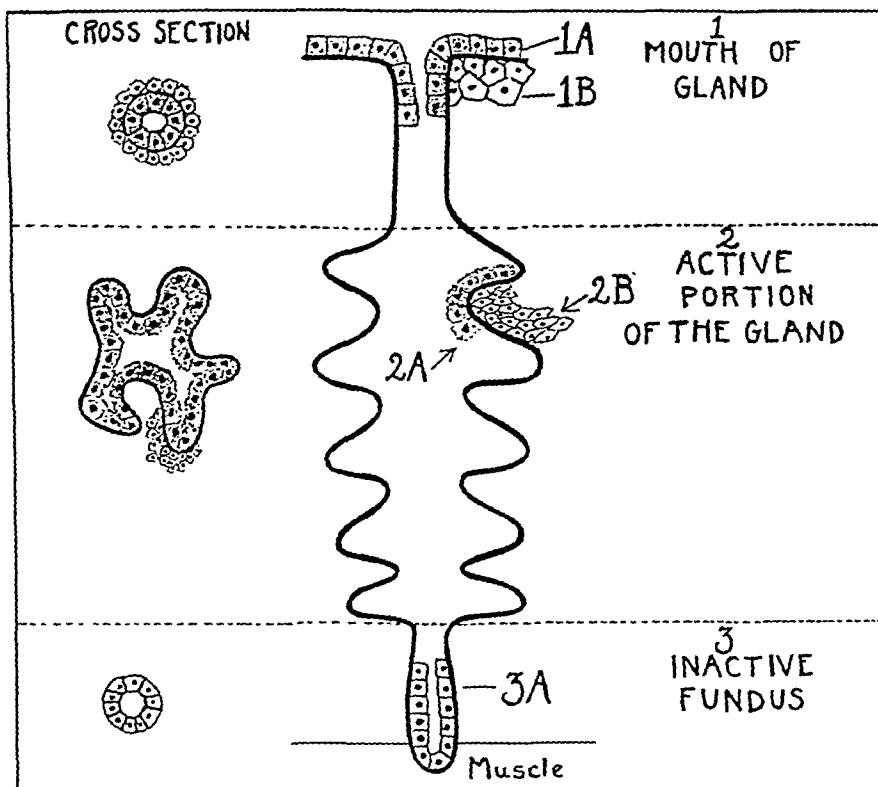


FIG. 96. Diagrammatic representation of a uterine gland in the premenstrual secretory phase. 1A, epithelium lining cavity of the uterus and mouth of the gland; 1B, edematous connective tissue, stroma cells of the compact layer; 2A, hyperplastic epithelium of the tortuous part of the gland; 2B, spindle cell shape of stroma in this region; 3A, low columnar epithelium of the inactive fundus.

lar cytoplasm (Fig. 96-1-A). The mouths of the glands are also lined by a high columnar epithelium with a central nucleus and glandular cytoplasm. Underneath the surface epithelium and between the mouths of the glands are found larger polyhedral connective tissue cells with central nuclei and clear cytoplasm (Fig. 96-1-B). These large connective tissue cells become the decidual cells of the pregnancy endometrium. It is this layer which forms the compact layer of the pregnancy endometrium; it is in this layer that the ovum imbeds itself in the earliest stages of pregnancy. There is very little or no

intercellular structure found in this layer except just before menstruation when there is usually a marked infiltration with lymphocytes, polymorphonuclear leucocytes and red blood cells. There are few blood vessels in this area. If any blood vessels are found, they are terminal endothelial lined spaces.

**SPONGY LAYER OF THE ENDOMETRIUM**, or tortuous part of the gland (Fig. 96-2). This comprises the active portion of the gland. The gland in this area assumes a corkscrew appearance. This is due to an attempt on the part of the gland to accommodate itself to the increased space required for the hypertrophied lining epithelium. The lining epithelium is high columnar with a central nucleus and a granular cytoplasm. It has the appearance of a stimulated epithelium. The epithelial cells look as if they were ready to burst into the lumen of the gland. They are not sharply demarcated from the lumen of the gland (Fig. 96-2A). In the lumen of the gland there is some secretion, which has been found to contain trypsin. This is a proteolytic enzyme which becomes activated in an alkaline medium. The cavity of the uterus is normally slightly alkaline. When this trypsin is released into the cavity of the uterus, it becomes activated and proteolytic digestion takes place.

The stroma (Fig. 96-2B) of this layer, is not so markedly hypertrophied as is the stroma of the compact layer. The connective tissue cells have a central nucleus and have retained their oval or spindle cell shape. There is a moderate amount of plasma (edema) between these cells. With the approach of menstruation one finds white blood cells, red blood cells and blood in the interstices. The blood vessels in this area are more numerous than in the compact layer. They are the terminal capillaries; they may be simple endothelial lined spaces or may have the beginning of a musculature in the walls.

**INACTIVE FUNDUS OR FUNDAL LAYER** (Fig. 96-3). This presents itself as a perfectly straight tubular gland lined by a low columnar epithelium (Fig. 96-3A) taking a very deep stain with hematoxyline. *The younger the cell, the more hematoxylin it takes.* They are the youngest epithelial cells of the entire gland. The stroma of this layer is a very dense connective

tissue; the arterioles are terminal arterioles with definite muscular walls. The gland fundii dip down into and rest upon the musculature of the uterine wall. *There is no submucosa.* When pregnancy takes place the inactive straight fundal glands disappear and become dilated.

*Diagnostic Point: When a patient presents herself with an amenorrhea and examination of the cast-off or curetted endometrium shows dilated fundal glands and no trophoblasts, a diagnosis of tubal pregnancy must be considered.*

As a result of certain endocrinological changes menstruation occurs. If a cup were placed in the vagina of a menstruating woman and all the material discharged from the cervix collected and examined chemically and microscopically, one would find on the *first day* that the first discharge would be a moderate amount of serum. Many women complain that just before the bleeding actually starts, they feel quite wet. This is apparently due to a discharge of serum from the hypertrophied connective tissue cells of the compact layer. This serum would be followed by a considerable amount of blood, some tissue, and an appreciable amount of trypsin. On the first day, uterine epithelium was demonstrated in the centrifuged specimen, on section in 50 per cent of 100 cases studied by Geist.

On the *second day* there is a definite increase in the amount of blood and in the amount of uterine stroma and epithelium discharged. There is a definite diminution in the amount of trypsin. This is due to the fact that trypsin is not being produced during menstruation. Trypsin is produced by the glands from one menstrual period to the next.

On the *third day* there is a moderate amount of blood, some uterine stroma and practically no trypsin.

On the *fourth day* practically nothing but blood is found.

If a daily examination of the endometrium could be made during menstruation, one would find that during the first day or so the upper part of the gland (the compact layer) with the accompanying edematous connective tissue, is discharged. On the second day part of the active part of the gland accompanied by its connective tissue stroma, is discharged. On the third and

fourth days there is a gradual diminution in the cellular elements thrown off until nothing but blood is discharged. So that with the end of menstruation and the beginning of the postmenstrual period all that is left of the premenstrual gland is the inactive fundus.

Does this loss of tissue happen with every menstruation?  
No.

Does this change take place in all the glands with each menstruation? No.

The loss of endometrium may be as complete as described throughout the entire uterine cavity or it may go to the opposite extreme with practically little or no loss or only a patchy loss of the endometrium. In some areas the epithelium may simply lose its hypertrophied appearance, the glands straightening out and the connective tissue loses its edema.

**POSTMENSTRUAL ENDOMETRIUM.** The endometrium has shrunk very much in size and the cells have lost their marked appearance of stimulation. Many areas of denudation are present throughout the endometrium. As soon as the destructive process ceases, epithelial proliferation begins to cover the raw areas. This starts from surviving islets of epithelium and from the broken ends of the fundal glands. This proliferation of the remaining epithelium sets in very rapidly so that at about the end of the postmenstrual period the inactive fundii have regenerated, forming a simple tubular gland, and the epithelium has spread over the surface so that the uterus is again lined by epithelium on or about the tenth day after the first day of menstruation.

**INTERVAL ENDOMETRIUM.** With the beginning of the interval period the glands begin to show definite growth. They become elongated and the epithelium gradually becomes hypertrophied so that by the end of the interval period, there is a definite division of the gland into three parts: the mouth, the active portion, and the inactive fundus. Toward the end of the interval period secretion appears in the gland. The transition from the interval stage to the premenstrual one is very gradual and one frequently will find great difficulty differentiating a



late interval endometrium from an early premenstrual one.

What causes these changes?

What is the endocrinological background of all this?

There is no doubt that something in the ovary controls the various changes in the endometrium. It has been definitely established that if both ovaries are removed, menstruation ceases. But what particular structure in the ovary controls the endometrium?

The primordial follicle, containing the ovum and the various structures arising from it seem to control the changes in the endometrium. With the beginning of the cycle several of these primordial follicles show signs of activity (Fig. 97). As the primordial follicles proliferate they give off a secretion which is called female sex hormone (Frank), folliculin, theelin, etc. In this discussion the product will be called theelin. Somewhere between the fifth and the seventh day after the first day of menstruation, one of these primordial follicles begins to show signs of marked proliferation and goes on to the formation of a Graafian follicle. With each menstrual cycle, as a rule, only one Graafian follicle is formed.

As the Graafian follicle ripens and extrudes the ovum, the corpus hemorrhagicum and later the corpus luteum form. With the formation of these structures the other primordial follicles which had begun to proliferate, degenerate and disappear and the production of theelin is assumed by the corpus luteum (Fig. 97).

The ovum is extruded about the twelfth day after the beginning of menstruation. With the expulsion of the ovum, the Graafian follicle collapses, hemorrhage takes place into it with the formation of the corpus hemorrhagicum. Large polyhedral cells with central nuclei and granular cytoplasm, containing a lipid known as lutein, grow into the hemorrhagic area and by the twenty-second day the corpus luteum of menstruation is fully formed. The ovum during this time has continued its passage down the tube and if it has not become impregnated it dies on or about the twenty-sixth day. The

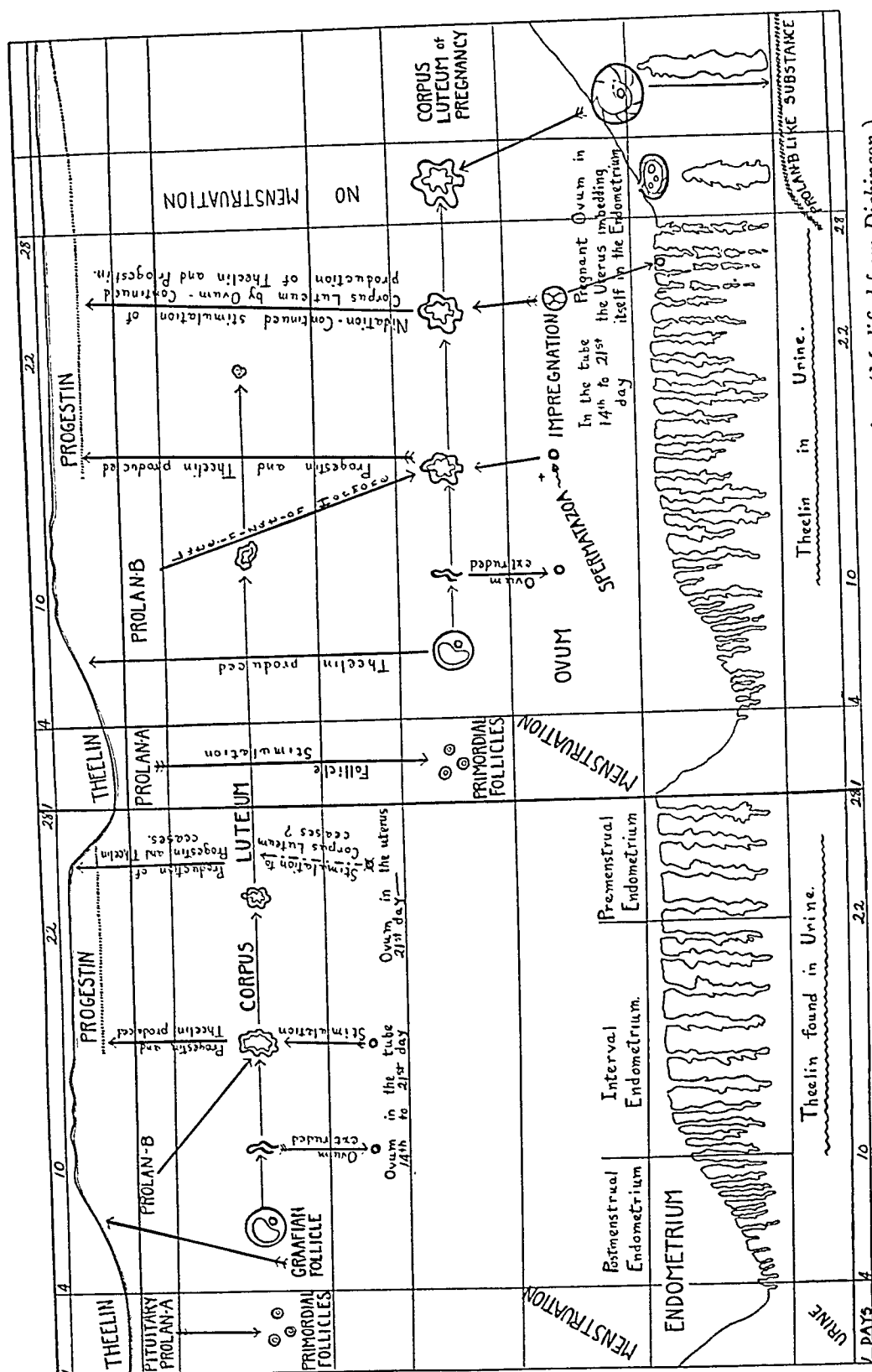


FIG. 97. Schematic representation of the endocrinological background of menstruation. (Modified from Dickinson.)

lutein cells besides producing theelin, gives off another secretion known as progestin (Fig. 97). The corpus luteum is supposed to function (if the ovum does not become impregnated) until about the twenty-sixth or twenty-seventh day after the first day of menstruation, then regression takes place.

What correlation is there between these ovarian changes, the endocrinological changes and the changes in the endometrium?

With the end of menstruation there is practically no theelin in the blood. The early postmenstrual changes can be ascribed to the normal healing or regenerative processes. With the proliferation of the primordial follicles and the formation of the Graafian follicle, the theelin content of the blood gradually increases until it reaches a plateau. Theelin causes the late postmenstrual changes and all other changes in the endometrium up to the end of the interval period. Theelin also sensitizes the endometrium to the action of progestin. Progestin produces the premenstrual changes, the secretory phase, in an already sensitized endometrium. (Theelin and progestin are both produced by the corpus luteum.)

What causes these various changes to take place in the ovary?

The stimulus which initiates follicular activity comes from the anterior pituitary lobe and is called prolactin A (Fig. 97). The hormone which causes the luteinization of the follicular epithelium also comes from the pituitary gland, is called prolactin B. The ovum apparently maintains the life of the corpus luteum. With the death of the ovum, stimulation to the corpus luteum ceases; with its cessation, the production of progestin and theelin ceases, and the stimulation to the endometrium stops. With the cessation of the stimulation, the edema of the compact layer of the endometrium is discharged and the mouths of the glands open; trypsin is expelled into the cavity of the uterus and proteolytic digestion takes place. The blood vessels rupture and menstruation occurs.

The corpus luteum ceases to function with the death of its particular ovum. If pregnancy takes place, that ovum imbeds

itself into the endometrium and continues to stimulate its corpus luteum forming the corpus luteum of pregnancy (Fig. 97). The corpus luteum in turn continues to stimulate the endometrium for two to three months. If the corpus luteum of pregnancy is removed in less than three months, the patient may abort. The placenta when formed assumes some of the functions of the corpus luteum.

*Menstruation without ovulation can take place, in such cases the endometrium does not develop beyond the late interval stage, e.g., the twenty-second day endometrium. This is due to the absence of progestin. A premenstrual hyperplasia (secretory phase) will not be found if a patient who menstruates without ovulating, is curetted.*

Bleeding around the middle of the period might be due to fluctuations in the folliculin content of the blood, as the rupture of the Graafian follicle takes place at this time.

The theories as to the cause of menstruation are many, but the true factor is still a matter of much speculation.

Theory 1. There is a gradually increasing amount of evidence tending to prove that menstruation is due to a change in the theelin content of the blood, a lowering of the theelin concentration level in the blood (Fig. 97). Just what this level is, how much theelin shall be called the normal amount, is not definitely known.

What is the presumed endocrinological mechanism which brings about this theelin level?

The primary stimulation factor comes from the pituitary gland, prolactin A, which is a follicle stimulating hormone, causing several primordial follicles to proliferate. One of these follicles for some unknown reason goes on to form the ripe follicle, the Graafian follicle; the other degenerate and disappear.

The summation of the internal secretion of these follicles produces a sufficient amount of theelin to inhibit this activity of the pituitary gland and to stop further follicle development. With the rupture of the Graafian follicle, the second pituitary hormone is secreted, prolactin B, which is the luteinization hor-

monone and produces the luteinic changes in the follicular cells of the Graafian follicle. The lutein cells produce theelin and thus maintain the necessary level. About one to two days before menstruation begins the corpus luteum begins to retrogress, the theelin level is lowered and menstruation results. With the lowering of the theelin level the inhibition on the pituitary is removed and prolactin A again functions and the cycle is repeated.

### Theory 2. Ovulation and menstruation.

For many years menstruation was regarded as the abortion of a nonimpregnated ovum—no ovulation, no corpus luteum—no corpus luteum, no menstruation—was Robert Meyer's dictum. The summation of the internal secretion of the primordial follicles stimulates the endometrium until the Graafian follicle ruptures and the ovum is extruded. The corpus luteum is then formed. As long as the ovum remains alive it stimulates the corpus luteum which produces theelin and progesterone. With the death of the ovum, retrogression of the corpus luteum occurs. The production of theelin and progesterone ceases, and the stimulation which produced the thick, hyperplastic premenstrual endometrium stops. The decidua-like cells (subepithelial connective tissue cells of the stroma) which became hypertrophied as a result of the stimulation by progesterone kept the mouths of the glands closed. With the stoppage of this stimulation the connective tissue cells lost their edema. Some women state that a day or so before they actually begin to menstruate, they feel quite moist as a result of the loss of this fluid. The loss of edema causes the mouths of the glands to open, the contained trypsin is discharged into the uterine cavity and proteolytic digestion begins. Trypsin also prevents the coagulation of the blood. With the stoppage of the stimulation and the release of pressure on the outside of the vessels, the thin walled structures rupture, bleeding takes place—this plus the trypsin digestion produces menstruation.

How long will the ovum live after being discharged from the Graafian follicle?

It is probably viable and vulnerable to impregnation for only a short period, but its effect on the corpus luteum, if the ovum does not become impregnated, lasts about fourteen days.

A patient presents herself with a menstrual disorder. How shall one go about establishing the proper diagnosis?

Before a menstrual disorder can be attributed to any functional disturbance, all other organic or pathological conditions which might cause that disorder must be eliminated. The history should be taken with special reference to the periodicity of the symptoms so as to fix them in relationship definitely with, or as a cause of, the menstrual disturbance. The physical examination should rule out any gross pathological condition. Following this certain tests can be performed in an attempt to fix the responsibility for the menstrual disorder.

#### TESTS AND EXAMINATIONS

1. *The daily theelin variations* in the blood and urine of the patient from one menstrual period to the next, can be estimated. This is very expensive, costing about \$150. for one month's tests. The information obtained, however, may be very valuable. It is by far the most accurate method of determining exactly how much ovarian function is going on. Clinically one may, by inference, as a result of a careful history and physical examination, judge hypoovarian function by searching for signs of juvenilism (see Chapter VIII, Sterility).

2. *Basal Metabolism.* The close relationship between the thyroid and ovary requires a complete knowledge of the state of function of that gland. Hypofunction or hyperfunction of the thyroid may cause ovarian dysfunction.

3. *Examination of the Pituitary.* There is no accurate way of determining the function of the pituitary gland. One must work by inference depending upon tests and examinations to give a lead to the pituitary function. X-ray examination of the sella turcica is done: What is its size? Is it too small? Is it too large? Is any tumor demonstrable? A tumor may mean hyperfunction or pressure atrophy with loss of function. Are the

fundi normal? Has there been encroachment upon the visual fields? What is the sugar tolerance of the patient? All of these examinations and tests give indirect information as to pituitary function.

4. *Curettage*. This is a simple and yet a very valuable examination. It is practically an office procedure.

These tests are time-consuming, expensive and after all the tests are performed, the question as to whether an accurate endocrinological diagnosis has been established is frequently in doubt.

If examination of the curettings removed two or three days before the expected menstrual period shows the presence of a premenstrual endometrium it is indicative of a previous ovulation and the presence of an ovum. A premenstrual (secretory phase) endometrium shows the presence of progesterin; the latter is produced by a corpus luteum which structure arises from a Graafian follicle following the extrusion of an ovum. From the absence of a secretory endometrium one must infer that ovulation has not occurred. As all chemical tests for progesterin have failed, to date, curettage is the only means of demonstrating the occurrence of ovulation.

5. *Allergy*. Recently many menstrual disorders as well as other gynecological conditions have been ascribed to allergic phenomena. The diagnosis of these allergic phenomena is as yet very difficult. One must, for the present, until further data is available, depend upon the history and periodicity of the attacks as a lead to this diagnosis.

**Axiom :** You cannot make a diagnosis unless you know the disease and think of it.

In those cases where a fairly accurate endocrinological diagnosis can be established, rational organotherapy is very problematical. It is expensive and frequently ineffectual. It is difficult to maintain proper standards with the commercial endocrine substances used because so many of them deteriorate rapidly and very often the dosage used is much less than the one marked on the container. Wherever possible, synthetic, stable products should be used. Unfortunately there are as yet

no such products for the various ovarian hormones. One of the few organotherapeutic procedures that has proved to be of uniform value has been the use of thyroid gland substance in cases with low basal metabolic rates. There is no question that the basal metabolism can be raised with thyroid substance.

### AMENORRHEA

It is of paramount importance in all menstrual irregularities in young women, to impress the patients and their mothers with the fact that there is nothing in the body that must be expelled every month with menstruation and that the condition is compatible with good health and does not necessarily mean some serious constitutional ailment.

Clinically the amenorrheas may be divided into two large groups:

1. Primary amenorrhea, those patients who have never menstruated, usually young women or adolescents;
2. Secondary amenorrhea, those who have menstruated regularly or irregularly for a period of time and now do not menstruate.

In the primary amenorrheas one must first exclude all abnormalities of the gynecological tract such as absence of vagina or uterus, atresia of the vagina, stenosis of the cervix, etc.

What can be done for these patients with primary or secondary amenorrhea? A large percentage of these patients will ultimately regulate their own internal secretory functions. It is only necessary to tide them over this period psychologically until the glands begin to function normally. Good hygiene, outdoor exercise, "put them out to grass" (Cragin), stop most indoor work, diminish all social activities, create regular bowel and sleeping habits, all of these will help the patient establish her normal physiological-endocrinological balance.

It is in this type of case that it is essential to know if the ovaries are functioning. Is any theelin being produced? Frank divides these cases into three groups:



A. *Subthreshold Group*. Those patients showing a regular curve of the accumulation of theelin (female sex hormone) in the blood but not sufficient to produce the changes necessary to cause menstruation;

B. *Negative Blood Cycle* (high theelin content in the urine). Those cases showing no accumulation of hormone in the blood on repeated examinations and yet show an excess in the urine (low renal hormone threshold).

C. *Negative Blood and Urine Cycle*. Those showing no demonstrable quantity of theelin in either their blood or urine. Clinically B and C can be considered together.

What can be done to produce and maintain the proper theelin concentration in the blood of a patient?

The maintenance of a proper theelin level is difficult and uncertain because the normal level in any patient is not known and therefore the amount of theelin necessary to maintain this level cannot be known. All examinations and tests for theelin are made on the basis of rat units, that is to say, the quantity of theelin necessary to produce an estrus cycle in the vagina of an immature rat. The dosage that is required to produce the same sort of changes in the human is very problematical. If the dosage is gauged on the relative weights of the rat and the human, one would have to use 1000 times the amount used on a rat. In other words, to maintain the supposed proper female sex hormone level in the blood of a human would require 200,000 rat units equally spread over a one month period. This is very expensive and the results are very doubtful.

In the subthreshold group theelin may be given over short periods of time; 10,000 rat units three times a week for two weeks and if no bleeding occurs it can be repeated in two weeks. This may be sufficient to produce a stimulation of the endometrium and cause bleeding (not regular menstruation). This bleeding has an excellent psychological effect on the patient and helps tide the patient over until regular function is reestablished. This however, should not be continued for too long a period of time, nor be too excessive, as it may cause destructive changes in the ovaries.

What can be done for those patients showing no theelin in the blood? If large doses of theelin are given patients with non-functioning ovaries, an interval endometrium can be produced with bleeding. There is no better way of explaining this effect of large quantities of theelin in the non-menstruating woman than by quoting Novak who says, "It is like pushing the pendulum of a run-down menstrual clock for a single, idle, incomplete beat, when what we need is something to wind the clock."

Has anything actually been accomplished therapeutically by giving large doses of theelin? An interval endometrium has been produced, bleeding has occurred, but the ovaries have not functioned in any way. To have this patient bleed again it will be necessary to give her another course of theelin so as to produce another endometrium. Therapeutically, what is wanted, is not something to cause a single bleeding from the endometrium but something which would stimulate the ovaries to function, e.g., to "wind up the ovarian clock" and have it continue to function.

The dominant role of the anterior lobe of the pituitary over ovarian function is generally accepted. This would suggest that the key to "winding up" the menstrual clock might be sought in the anterior hypophysis.

The use of large doses of Prolan A, which is the follicle stimulating hormone, would be the ideal approach. However, prolan A as yet has not been produced commercially, nor has it been definitely isolated.

The usual pituitary product sold is a prolan B-like substance obtained from the urine of gravid women. This contains a product similar to the luteinizing principal of the pituitary gland. This prolan B-like substance acts on the follicular epithelium of the ovary which is supposed to become luteinized and produce progesterin. This in turn can act only on an endometrium sensitized to it by large doses of theelin. This product would therefore be of no value in amenorrhea, particularly when due to non-functioning ovaries.

What can be done to "wind up" the menstrual clock?

Anything which would start the ovaries functioning "winds up the ovarian clock" and cures the amenorrhea. *Very small doses of x-ray stimulation to the pituitary and ovaries may start them functioning, and thus "wind up the menstrual clock" and cure the amenorrhea.*

The treatment of the secondary amenorrhea, oligomenorrhea or hypomenorrhea depends to a large extent upon the desire of the patient to have children. If there is no desire for pregnancy, no treatment other than psychotherapy need be instituted, as these conditions are compatible with a normal life. Should pregnancy be desired, the regular daily estimation of the theelin content of the blood and urine becomes of tremendous importance. These patients as a rule, belong to the "subthreshold" group of Frank. Their ovaries are functioning but are not producing enough theelin to cause the normal menstrual cycle. These patients can be helped to a fairly normal amount of bleeding (empirical) by giving 10,000 rat units of theelin every day or every other day for two weeks before the expected date of menstruation. This may cause a more profuse bleeding in the oligomenorrhea and hypomenorrhea patients. This procedure may be carried out every month for six months, in the hopes that the patient may reestablish her own interglandular relationship and thereby raise the theelin content of her blood spontaneously. Its effect is mainly psychological during the period of readjustment. As a last resort one may use *very small* doses of x-rays to stimulate the ovaries to function normally.

#### MENORRHAGIA, METRORRHAGIA

For therapeutic purposes these patients should be divided into their respective age groups, adolescent, middle age and menopausal. Clinically they may be grouped according to their symptomatology into the moderate or severe bleeding, depending upon the amount and frequency of the bleeding and the degree of anemia present.

The irregular bleeding of the adolescent is usually due to some endocrinological imbalance. These patients should be

psychologically assisted over this period. The prognosis is good as most of these cases correct themselves spontaneously.

The profuse irregular bleeding of the adolescent may be caused by a hyperproduction of theelin with a non-ovulatory endometrium, e.g., bleeding from an endometrium which has not entered the premenstrual or secretory phase due to the absence of one of the ovarian hormones, progesterin. Progesterin is one of the hormones produced by the membrana granulosa cells of the Graafian follicle after ovulation has taken place and luteinization has begun. In such cases good results should be obtained by the use of prolan B, the luteinization hormone of the pituitary or progesterin itself, but as these products cannot be obtained commercially\* a prolan B-like substance obtained from the pregnancy urine is used. This substance is supposed to cause a luteinization of the follicular epithelium in the follicle. This has been tried but not proved on human ovaries. This luteinized epithelium produces progesterin which in turn produces the premenstrual or secretory endometrium. Theoretically this should correct the irregularity. Therapeutically (empirically) the patient should receive 200 to 400 rat units of the prolan B-like substance every day for five days before the bleeding starts. If the patient has menorrhagia, the injections may be given with the onset of menstruation. If the patient is irregular, the injections may be begun at any time. The injections of the prolan B-like substance may have to be repeated several times before the flow regulates itself.

In cases of severe hemorrhage in adolescence, curettage may be performed. This will usually help the condition for a short time. During this period endocrine therapy should be tried. If the bleeding recurs and is again severe, a temporary sterilization dose of x-rays should be tried; with the hope that when menstruation returns the interglandular relationship will have been reestablished and the periods will be normal. One must watch these cases very carefully and not allow them to get out

\* Some of the commercial houses are selling a product which they claim contains the prolan B of the pituitary gland. Others claim they have been able to isolate progesterin for commercial use. Both products are still in the experimental stage clinically.

of hand. The bleeding, when excessive can cause such severe anemia as to require repeated transfusions.

Goldberger and Peck\* have reported good results in these bleeding cases with the use of snake venom. Their "Method of Administration" is described verbatim.

The moccasin venom was used in a 1:3000 dilution with sterile sodium chloride (normal) containing 1:10,000 merthiolate.

All injections were given subcutaneously. The initial injection was 0.5 c.c. and subsequent injections were rapidly increased to 1 c.c. (by the third injection). The interval between administrations of the venom depended on the severity of the bleeding. It was advisable to give as much venom as possible the first ten days, because at about that time the majority of patients developed a sensitivity to the venom which necessitated a decrease in the amount until desensitization was accomplished.

There was a distinct quantitative relationship between the desired clinical effect and the amount of venom given. In cases with marked bleeding, 1 c.c. of 1:3000 dilution was given daily or even twice a day until the hemorrhage was controlled. In a number of the patients, daily injections were given at the beginning of the treatment. After the bleeding had been controlled the interval between injections of venom was increased so that only two or three treatments were given weekly.

If the subsequent menstrual period approximated the normal, two injections a week were administered for at least three normal menstrual periods. During the course of the treatment a maintenance dose had to be established.

In a number of the treated individuals a period of six months to one year of normal menstruation occurred after the venom therapy had been discontinued. When metrorrhagia or menorrhagia recurred and venom was again administered, the initial dose was 1 c.c. If such a patient reported for treatment early enough, several 1 c.c. injections given two or three times weekly were found to be sufficient to bring about normal menstrual bleeding. It has also been noted that the course of injections necessary to control recurrences of bleeding was shorter than that necessary at the beginning of the treatment.

When patients in the middle age or menopausal group present themselves with moderate to severe bleeding, curettage as a therapeutic and diagnostic procedure should be tried early. The most important single therapeutic agent in the treatment

\*GOLDBERGER, M. A. and PECK, S. M. Additional data on treatment of uterine bleeding with snake venom. *Am. Jour. Gynec. and Obst.*, 33: 469-472 (March) 1937.

of functional uterine bleeding is the curette. Curettage usually stops the excessive bleeding for several periods and also allows a careful examination of the tissue obtained to rule out the possibility of an undiagnosed incomplete abortion or an early carcinoma of the fundus. One may also in this way diagnose a non-ovulatory hypertheelin bleeding with a late interval endometrium, e.g., "Swiss cheese endometrium." The middle age group with excessive bleeding who are desirous of retaining their procreational capacity are treated the same as the adolescent with moderate to severe bleeding. If however, no further pregnancies are desired these patients should be treated like the menopausal group.

In the menopausal group, a castration dose of x-rays is frequently given without trying any of the mentioned treatments other than curettage. Radium has the same effect as x-rays but has the added effect of destroying the endometrium. Surgery in the form of oophorectomy or hysterectomy can be practised as a last resort.

### DYSMENORRHEA

No attempt will be made to enumerate the various etiological factors or theories of dysmenorrhea. The problem will be approached from a purely clinical standpoint.

A patient presents herself complaining of dysmenorrhea. It is presumed that all gross pathological lesions have been ruled out. The severity of her complaint may be judged by the amount of incapacitation it causes. Is she able to carry on her normal work or does she have to stay in bed with each period?

What shall be done for her?

A fair number of cases may be relieved with Holden's capsules.

|                         |                     |                    |
|-------------------------|---------------------|--------------------|
| Rx: Phenacetin.....     | gr. 2.5             | to 5               |
| Aspirin.....            | gr. 2.5             | to 5               |
| Atrophine Sulphate..... | gr. $\frac{1}{150}$ | to $\frac{1}{100}$ |
| Codeine.....            | gr. $\frac{1}{4}$   | to $\frac{1}{2}$   |

One of these capsules should be given just before the onset of the period followed by two capsules every four hours until the

period of pain has passed. In the mild to moderate cases these capsules may be used without the codeine. In the severe cases the codeine may have to be increased. The use of codeine in the capsules, in patients who have to remain at work, has the disagreeable effect of making them somnolent and as a result frequently has to be omitted. In a fair number of cases this is all that will be necessary, if found insufficient, heat in the form of Elliott's treatment for thirty minutes daily for one week before the onset of menstruation has proved efficacious and should be tried. It should be used before three or four periods for the best results. Heat in the form of hot vaginal douches, electric pads and hot Sitz baths may be of help. Many authors recommend viburnum, given over a long period of time, three times daily for two months in hot water. This is supposed to cause a relaxation of the spastic uterine muscle.

It has been observed that some severe cases of dysmenorrhea which do not respond to ordinary therapy have been relieved by marital life or pregnancy.

Reynolds and Novak believe that an "abnormal amount of theelin with a diminished amount of progesterin causes dysmenorrhea" (theoretical). This increased quantity of theelin is supposed to heighten the irritability of the uterine musculature and they believe this heightened irritability is the immediate factor in the production of pain. They recommend the prolan B-like hormone in dysmenorrhea. This luteinization hormone from the urine of pregnant women, is supposed to luteinize the epithelium of the ripe follicles and thus produce the necessary progesterin. If the new commercial progesterin proves of value clinically it should be tried in these cases.

Surgery may be required for the severe cases that have not been relieved by these procedures. A dilatation and curettage with the insertion of a stem pessary for three periods should be the first procedure.

*Warning.* Do not use a pessary that is longer than  $\frac{2}{3}$  the length of the uterus. Sew it in place with nonabsorbable suture material. If a longer pessary is used the continuous contractions of the uterus will force the pessary out too soon.

If the pessary fails, resection of the presacral nerves has proved effectual even in the most stubborn cases. It is not very difficult technically and the results are frequently brilliant.

The induction of a temporary amenorrhea with x-rays as a treatment for dysmenorrhea has proved valuable not only as a therapeutic agent but also for its diagnostic value. If the pain does not stop with the amenorrhea one must search elsewhere than the uterus for the etiology of the pain.

### MENOPAUSAL SYMPTOMS

The menopausal symptoms are due to endocrinological changes. In most cases the symptoms of hot flushes, sweating, irritability, etc., are self-limited and frequently yield to some mild form of therapy. The use of theelin and thyroid seems to help these patients. One may experiment with the various products and combination of products until the right one for the particular patient is found. With the glandular therapy one should also employ diet regulation, bowel hygiene and some form of nerve sedative, as the barbitals and bromides. The psychic factor in the control of their symptoms must constantly be borne in mind.

Question: What relationship has the thyroid to menstrual disorders?

Answer: All patients presenting themselves with menstrual disorders should have a basal metabolism test performed and if found below normal, thyroxin grain  $\frac{1}{320}$  to  $\frac{1}{160}$  twice daily should be given depending upon the rate. If the metabolic rate is increased and the patient is suffering from hyperthyroidism, mild or severe, the menstrual disorder may be disregarded and the thyroid dysfunction treated.

Question: What is the relationship of obesity to menstrual disorders?

Answer: Obesity in a large percentage of cases is due to overeating, and in a much smaller percentage it is due to some glandular dysfunction. All of these patients should be placed on a low carbohydrate, low fat, high protein diet and to overcome the asthenia they should receive calcium lactate grains 20



every morning on an empty stomach, e.g., before breakfast. If the basal metabolic rate is below normal they should receive thyroxin gr.  $\frac{1}{320}$  to  $\frac{1}{160}$  twice a day.

Question: Would you give x-ray stimulation to all amenorrheas?

Answer: Yes, after an eighteen month period during which all tests and treatments described have been tried.

Question: Are there any glandular products which would "wind up the menstrual clock"?

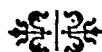
Answer: Numerous products have been tried without avail. The commercial houses are constantly trying to produce a prolan A-like substance, a follicle stimulating hormone. There are some on the market at the present time but their efficacy is very questionable.

In this connection it is surprising to note the small quantity of ovarian tissue that may be left in a patient at operation and still have her menstruate normally and yet patients with infantile uteri and two normal appearing ovaries do not menstruate. Apparently something more than the ovaries is necessary for regular menstruation. If this other stimulating substance, whether it be prolan A, x-ray or what not, could be given the patient, menstruation could be reestablished.

*[To be continued in subsequent issues.]*

# AUTHOR INDEX TO VOLUME XXXVI

- Armstrong, W. P. Jr., 332  
 Arons, Isadore, 533  
 Astley, G. Mason, 362  
 Babcock, W. Wayne, 3  
 Ballenger, Edgar G., 174  
 Bandler, Clarence G., 162  
 Barber, Robert F., 386  
 Bassen, Edward J., 93  
 Bate, John T., 500  
 Beisler, Simon A., 213  
 Belson, Maurice O., 221  
 Bender, Morris S., 462  
 Best, R. Russell, 611  
 Rochner, S. Judd, 279  
 Borsher, Irving P., 398  
 Bowen, Arthur, 694  
 Boyers, L. M., 623  
 Breidenbach, Lester, 308  
 Cahill, George F., 653  
 Caldwell, John A., 736  
 Charache, Herman, 551  
 Charlton, M. R., 703  
 Church, Reynold Erskine, 57  
 Coakley, Walter A., 50  
 Coombs, James Norman, 366  
 Cooper, Henry S. F., 11  
 Cowett, Max P., 262  
 Curtis, Dean, 122  
 Dealy, Frank N., 132  
 DeCourcy, Joseph L., 283  
 DeOrsay, Ralph H., 313  
 Desjardins, Arthur U., 603  
 Dickinson, Arthur M., 663  
 Dinnerstein, Morris, 421  
 Donald, D. C., 514  
 Drummond, Alvin C., 180  
 Druss, Joseph G., 102  
 Dunn, Edward P., 44  
 Dunn, Fred Squier, 83  
 Dworkin, Martin, 403  
 Elder, Omar F., 174  
 Epstein, Ervin, 472  
 Falk, Henry C., 31, 559, 750  
 Fardelmann, Adolf Von Prief, 527  
 Ferguson, L. K., 270, 313  
 Ferguson, L. Kracer, 313  
 Festerling, E. G., 360  
 Fett, Herbert C., 288  
 Frazier, W. D., 672  
 Gilbert, Judson B., 711  
 Glass, Morris, 487  
 Glenn, Frank, 734  
 Gordon, Charles A., 418  
 Gordon, Donald, 107  
 Graham, James, 339  
 Greene, Lloyd B., 204  
 Haas, S. L., 720  
 Hamby, Wallace B., 732  
 Hamilton G. Johnson, 240, 618  
 Hark, F. W., 69  
 Harris, Franklin I., 443  
 Hawkes, Stuart Z., 398  
 Henderson, John, 125  
 Hicken, N. Frederick, 611  
 Hurley, Vincent, 259  
 Hyams, Joseph A., 189  
 Iason, Alfred H., 376  
 Jeck, Howard S., 197  
 Kaminester, Sanford, 700  
 Kassebohm, Fred A., 491  
 Katz, Abraham, 520  
 Kelly, Joseph D., 77  
 Key, J. Albert, 466  
 Kickham, Edward L., 178  
 Kirschenmann, J. J., 349  
 Kirshbaum, J. D., 476  
 Leddy, Eugene T., 603  
 Levy, Edward, 244  
 Lichtenstein, Manuel E., 620  
 Ludlum, Walter D. Jr., 520  
 Lynch, Jerome Morley, 240, 618  
 Mabry, Charles B., 292  
 MacAusland, Andrew R., 320  
 Magoun, James A. H., 717  
 Mason, James B., 505  
 Mathews, Harvey Burleson, 233  
 Mathieu, Albert, 219  
 Mayer, Edgar, 403  
 McCarty, Claude E., 531  
 McCauley, John C. Jr., 303  
 McDonald, Harold P., 174  
 McNealy, R. W., 620  
 Mecray, Paul M., 270, 313  
 Meyer, Herbert Willy, 724  
 Milbert, Arthur H., 162  
 Morgan, C. Naunton, 252  
 Morse, Joseph L., 137  
 Mulholland, John H., 323  
 Murphy, Charles C., 384  
 Murphy, Hugh L., 370  
 Myerson, Mervin C., 151  
 Narat, Joseph K., 54, 550, 729  
 Neef, Frederick Emil, 231  
 O'Connor, Bernard A., 544  
 Olin, Harry A., 476  
 O'Sullivan, John R., 544  
 Phaneuf, Louis E., 226  
 Pratt, Gerald H., 118  
 Preston, Robert L., 298  
 Rapoport, E., 249  
 Rathbun, N. P., 739  
 Rosenwasser, Harry, 96  
 Ryan, Thomas J., 708  
 Sammis, Frank, 46  
 Scannell, John M., 26  
 Schmier, Adolph A., 389  
 Schnepp, Kenneth H., 351  
 Schreiber, Milton J., 491  
 Shands, A. R., 679  
 Smyth, Calvin M. Jr., 505  
 Sokoloff, Boris, 533  
 Solomon, David I., 737  
 Som, Max L., 462  
 Soresi, A. L., 668  
 Spiesman, Manuel G., 17  
 Steel, William A., 37  
 Stern, Elias Lincoln, 509  
 Stevenson, Clyde A., 603  
 Stout, Gurn, 412  
 Straith, Claire L., 88  
 Tamerin, Joseph A., 91  
 Thomas, H. B., 69  
 Thorek, Phil, 22  
 Tilley, Albert R., 421  
 Toll, Robert M., 328  
 Tollman, J. P., 611  
 Torpin, Richard, 172  
 Turner, Horace E., 385  
 Updegraff, Howard L., 94, 414  
 Vickers, Denver M., 73  
 Wagner, Jerome, 266  
 Walkling, Adolph A., 705  
 Weaver, Hiram C., 523  
 Weeks, Carnes, 421  
 Weeth, Charles Reed, 159  
 Weiskittel, Richard J., 145  
 Welton, Thurston, 14  
 Wescott, H. H., 290  
 White, Alfred S., 443  
 Whitman, Royal, 553  
 Woodruff, I. Ogden, 421  
 Wyeth, George A., 63  
 Zaph, S. D., 476



# SUBJECT INDEX TO VOLUME XXXVI

(Bo.B.) = Bookshelf Browsing; (E.) = Editorial; (S.) = Serial

- A**bnormalities of rectum, congenital, 240
- Abortion, treatment of 487
- Abscess, ischiorectal, 279  
peritonsillar, 159
- Acute lymphangitis, 37  
pyogenic parotiditis, 125  
regional (terminal) ileitis, 708  
retention of urine, 162
- Adhesive, use of, in orthopedic practice, 290
- Alcohol; chronic painful conditions amenable to relief by intraspinal (subarachnoid) injection of, 509
- Ambulatory saphenous ligation, 398
- Anastomoses; a new insufficient and technique for intestinal, 544
- Anastomosis, new instrument for intestinal, 734
- Angina pectoris and congestive failure, total thyroidectomy in, 421
- Angiomata of skeletal muscle, 69
- Ano, fissure in, 244
- Appendix, mucocele of, with pseudomucinous degeneration, 523
- Application of radium in carcinoma of uterine cervix, 231
- Artificial pneumothorax, 403
- Auditory canal, foreign bodies in external, 96
- B**artholin's gland abscess or cyst; office treatment of, 219
- Bedsore (decubitus), 17
- Benign tumors of back, 145
- Bicornuate uterus, pregnancy in rudimentary horn of, 700
- Biliary tracts, morbidity and mortality following operations on, 505
- Biopsy of uterine cervix, 226
- Bites, human, 44
- Bladder and urethra, rupture of, 653  
removal of foreign bodies from urethra and, 197
- Blank cartridge cannon shot wound of leg, 724
- Blood transfusion, 26
- Boils and carbuncles, treatment of, 107
- Bone fixation, device for tightening wire for, 736
- BOOK REVIEWS:**  
Aural therapy in relation to deafness (Fraser-Harris), 745  
Diseases of the coronary arteries and cardiac pain (Levy), 747  
Recent advances in laryngology and otology (Stevenson), 745  
Recent advances in genitourinary surgery (Bailey), 416  
Textbook of general surgery (Cole), 745  
Textbook of surgical nursing (Keller), 747  
Textbook of surgery (Homans), 746  
The eye and its diseases (Berens, Ed.), 746  
The thyroid: surgery; syndromes: treatment (Sloan), 416  
Urology (Keyes & Ferguson), 416
- BOOKSHELF BROWSING:**  
Sketch of the evolution of American orthopedic surgery, 553  
The life and times of Thomas Sydenham, 731
- Breast; mammographic recognition of intracystic papilloma of, 611
- Bunion, treatment of hallux valgus, 332
- Burns, 50  
treatment with brilliant green, 54
- C**ancer of ureter, primary. Studies of the natural history of genitourinary tumors, 711
- Carbuncles and boils, treatment of, 107
- Carcinoma of uterine cervix; application of radium in, 231
- Caruncle, urethral, 178
- Cecostomy, simple technique for, 620
- Cervix, application of radium in carcinoma of uterine, 231  
biopsy of uterine, 226
- Chronic painful conditions amenable to relief by intraspinal (subarachnoid) injection of alcohol, 509
- Cinders and splinters, 94
- Circumcision; dorsal slit; constriction of male meatus; phymosis and paraphymosis, 174  
simplified anatomical technique, 172
- Claw foot and hammer-toe, 351
- Clinical comparison of sclerosing solutions in injection treatment of varicose veins, 389
- Clips, Michel, in skin coaptation, 14
- Clubfoot, treatment of congenital talipes equinovarus, 339
- Coccyx, fractures of, and coccygodynia, 303
- Cod-liver oil in skin ulcerations; local application of, 472
- Colles's fracture, 320
- Combined roentgenotherapy and ultra-short wave, 533
- Concealment of scars, 91
- Congenital abnormalities of rectum, 240
- Congestive failure and angina pectoris, total thyroidectomy in, 421
- Constriction of male meatus; dorsal slit; phymosis and paraphymosis; circumcision, 174
- Cryptitis, 249
- D**angers of roentgenoscopy and methods of protection (E.), 603
- Device for tightening wire for bone fixation, 736
- Diagnosis and treatment of stricture of male urethra, 189
- Distention; use of pitressin for control and relief of, 672
- Dorsal slit; constriction of male meatus; phymosis and paraphymosis; circumcision, 174
- E**DITIONALS:  
Dangers of roentgenoscopy and methods of protection, 603  
Maternal mortality and obstetric conscience, 418  
Embolism, pulmonary, 694  
Endocervicitis; pathology and office treatment of chronic, 233  
Epigastric hernia causing severe symptoms, 703
- F**acial scars, 88
- Failure, congestive, and angina pectoris; total thyroidectomy in, 421
- Feeding formula; useful artificial, 412
- Felon (Whitlow), 366
- Femur and hip; first aid treatment in fracture of, 323
- Fibroids (S.), 559

- Fingers; plastic restoration for loss of all, of both hands, 720
- First aid treatment of fracture of femur and hip, 323
- Fish hook embedded in finger; removal of, 384
- Fissure-in-ano, 244
- Fistula, gastrojejunocolic, 527
- salivary, 122
- Foreign bodies in external auditory canal, 96
  - rectum, 266
  - tracheobronchial tree, 462
  - removal of, from urethra and bladder, 197
- Fracture, Colles's, 320
  - of femur and hip; first aid treatment of, 323
- Fractures, malunited, of lower end of humerus, 679
  - of coccyx and coccygodynia, 303
  - mandible and maxilla, 83
  - neck of femur, insertion of Smith-Peterson nail for intracapsular, 466
  - nose, 77
  - ribs, 308
  - some aids in treatment of compound, 551
  - use of unpadded plaster in treatment of, 292
- Frost-bite: treatment by passive vascular exercise, 370
- Furuncle of upper lip, 118
- G**anglion; pathology and treatment of, 313
- Gas gangrene, 22
- Gastrojejunocolic fistula, 527
- Gastrostomy, inframural, 668
- Graft: new method of transfer of full-thickness skin; Grille, 46
- H**allux valgus (bunion), treatment of, 332
- Hammer-toe and claw foot, 351
- Hand infections: office treatment, 376
- Head, infections of, 57
  - malignant tumors of, 63
- Heart, right ventricle; stab wound of, 520
- Heater for intravenous solutions, 550
- Helpful drug in treatment of tuberculosis of urinary bladder, 500
- Hemorrhage following tonsillectomy, 151
- Hemorrhoids, 252
  - injection treatment of internal, 259
- Hernia, epigastric, causing severe symptoms, 703
  - the truss in relationship to diagnosis and injection treatment of inguinal, 443
- Hip and femur; first aid treatment in fracture of, 323
- Hirschsprung's disease and polyposis; sympathectomy for, 531
- Human bites, 44
- Humerus, malunited fractures of lower end of, 679
- Hydrocele and varicocele: operative and injection treatment, 204
- Hydronephrosis due to ball-valve obstruction from bullet lying free in renal pelvis, 717
- Hymen, imperforate, 221
- Hyperemesis gravidarum, 491
- I**leitis, acute regional (terminal), 708
- Imperforate hymen, 221
- Incisions of drum membrane in otitis media, 102
- Infections of head, 57
  - neck, 73
- Inframural gastrostomy, 668
- Infusions, intravenous, 31
- Ingrown toe-nail, 349
- Injection and operative treatment of hydrocele and varicocele, 204
  - treatment of inguinal hernia, the truss in relationship to diagnosis and, 443
  - internal hemorrhoids, 259
- Injection treatment of varicose veins; clinical comparison of sclerosing solutions, 389
- Injuries of the knee, office surgical treatment of, 328
- Injury, traumatic, of abdomen with extensive damage to colon and small bowel, 514
- Insertion of Smith-Petersen nail for intracapsular fractures of neck of femur, 466
- Intestinal anastomoses; a new instrument and technique for, 544
  - prolapse through enterostomy following Rammstedt operation, 729
- Intravenous infusions, 31
  - solutions, heater for, 550
- Ischiorectal abscess, 279
- K**eloids, warts and moles, 137
- Knee, office surgical treatment of injuries of the, 328
- Kut-Klamp: a new surgical instrument which simultaneously cuts and retains suture, 737
- L**eg, blank cartridge cannon shot wound of, 724
- Life and times of Thomas Sydenham (Bo.B.), 739
- Lip, furuncle of upper, 118
- Local application of cod-liver oil in skin ulcerations, 472.
- Lymphangitis, acute, 37
- Lymphosarcoma of stomach: clinical and roentgenological aspects, 476
- Lynch's simplification of perineal excision of rectum, 618
- M**alignant tumors of head, 63
- Malunited fractures of lower end of humerus, 679
- Mammographic recognition of intracystic papilloma of breast, 611
- Mandible and maxilla, fractures of, 83
- Maternal mortality and obstetric conscience (E.), 418
- Mechanical holder for retractors in neurosurgery, 732
- Meckel's diverticulum and volvulus of right colon, 705
- Michel clips in skin coaptation, 14
- Minor and office surgery (E.), 1
  - surgery of spine, 298
- Moles, warts and keloids, 137
- Morbidity and mortality following operations on biliary tract, 505
- Mucocele of appendix with pseudomucinous degeneration, 523
- Muscle; angiomas of skeletal, 69
- Muscles and tendons, rupture of, 283
- N**eck, infections of, 73
- Neurosurgery; mechanical holder for retractors in, 732
- New instrument and technique for intestinal anastomoses, 544
  - for intestinal anastomosis, 734
  - method for transfer of full-thickness skin: Grille graft, 46
- Nose, fractures of, 77
- O**bstetric conscience and maternal mortality (E.), 418
- Orthopedic surgery; sketch of the evolution of American (Bo.B.), 553
- Otitis media, incisions of drum membrane in, 102
- Office treatment of Bartholin's gland abscess or cyst 219
  - injuries of the knee, 328
- Operating room signals, 414
- P**apilloma of breast; mammagraphic recognition of intracystic, 611
- Paraphymosis and phymosis; circumcision; dorsal slit; constriction of male meatus, 174

- Paronychia, 362  
 Parotiditis, acute pyogenic, 125  
 Passive vascular exercise; frost-bite: treatment by, 370  
 Pathology and office treatment of chronic endocervicitis, 233  
     ganglion, 313  
 Peptic ulcers, subacute perforations of, 663  
 Peritonsillar abscess, 159  
 Phymosis and paraphymosis; circumcision; dorsal slit; constriction of male meatus, 174  
 Pilonidal cysts: excision and primary suture in ambulatory patients, 270  
 Pitressin, use of, for control and relief of distention, 672  
 Plaster-of-Paris, 288  
     use of unpadding, in treatment of fractures, 292  
 Plastic restoration for loss of all fingers of both hands, 720  
 Pneumothorax, artificial, 403  
 Polydactylism, 385  
 Polyposis and Hirschsprung's disease; sympathectomy for, 531  
 Practical clinical gynecology (S.), 559, 750  
 Pregnancy in rudimentary horn of bicornuate uterus, 700  
 Pruritus ani, 262  
 Pulmonary embolism, 694  
 Puncture wounds, simple treatment for, 360
- R**adium, application of, in carcinoma of uterine cervix, 231  
 Rectum, congenital abnormalities of, 240  
     foreign bodies in, 266  
 Rectum; Lynch's simplification of perineal resection of, 618  
 Removal of fishhook embedded in finger, 384  
     foreign bodies from urethra and bladder, 197  
 Retention of urine, acute, 162  
 Retractors, mechanical holder for, in neurosurgery, 732  
 Ribs, fractures of, 308  
 Roentgenoscopy, dangers of, and methods of protection (E.), 603  
 Roentgenotherapy and ultra-short wave, combined, 533  
 Rupture at bladder and urethra, 653  
     muscles and tendons, 283
- S**alivary fistula, 122  
 Saphenous ligation, ambulatory, 398  
 Scars, concealment of, 91  
     facial, 88  
 Sclerosing solutions in injection treatment of varicose veins; clinical comparison of, 389  
 Shock, 623  
 Shot wound of leg, blank cartridge cannon, 724  
 Signals, operating room, 414  
 Simple technique for cecostomy, 620  
     treatment for puncture wounds, 360  
 Skeletal muscle, angiomas of, 69  
 Sketch of the evolution of American orthopedic surgery, (Bo.B.), 553  
 Skin, full thickness, new method for transfer of; Grille graft, 46  
 Smith-Petersen nail, insertion of, for intracapsular fractures of neck of femur, 466  
 Some aids in treatment of compound fractures, 551  
 Spine, minor surgery of, 298  
 Splinters and cinders, 94  
 Stab wound of heart, right ventricle, 520  
 Stomach, lymphosarcoma of: clinical and roentgenological aspects, 476  
 Stricture of male urethra; diagnosis and treatment, 189
- Studies of the natural history of genitourinary tumors. 1: Primary cancer of ureter, 711  
 Styes, 93  
 Subacute perforations of peptic ulcers, 663  
 Sydenham, the life and times of Thomas, (Bo.B.), 739  
 Sympathectomy for Hirschsprung's disease and polyposis, 531
- T**alipes equinovarus (clubfoot), treatment of congenital, 339  
 Tendons and muscles, rupture of, 283  
 Thyroidectomy, total, in angina pectoris and congestive failure, 421  
 Toe-nail, ingrown, 349  
 Tonsillectomy; hemorrhage following, 151  
 Total thyroidectomy in angina pectoris and congestive failure, 421  
 Tracheobronchial tree, foreign bodies in, 462  
 Transfusion, blood, 26  
 Traumatic injury of abdomen with extensive damage to colon and small bowel, 514  
 Treatment of abortion, 487  
     boils and carbuncles, 107  
     burns with brilliant green, 54  
     congenital talipes equinovarus (clubfoot), 339  
     hallux valgus (bunion), 332  
     open infected wounds, 11  
     specific urethritis—new modality, 180  
     varicose veins and ulcers, 386  
 Truss in relationship to diagnosis and injection treatment of inguinal hernia, 443  
 Tuberculosis of urinary bladder; helpful drug in treatment of, 500  
 Tumors of back, benign, 145  
     head malignant, 63
- U**lcerations; local application of codliver oil in skin, 472  
 Ulcers and varicose veins, treatment of, 386  
     subacute perforations of peptic, 663  
 Ultra-short wave and roentgenotherapy, combined, 533  
 Ureter, primary cancer of. Studies of the natural history of genitourinary tumors, 711  
 Urethra and bladder; removal of foreign bodies from, 197  
     rupture of, 653  
     diagnosis and treatment of stricture of male, 189  
 Urethral caruncle, 178  
 Urethritis, treatment of specific—new modality, 180  
 Urinary bladder, helpful drug in treatment of tuberculosis of, 500  
 Urine acute retention of, 162  
 Useful artificial feeding formula, 412  
 Use of adhesive in orthopedic practice, 290  
     pitressin for control and relief of distention, 672  
     unpadding plaster in treatment of fractures, 292  
 Uterine cervix; application of radium in carcinoma of, 231  
     biopsy of, 226
- V**aricocele and hydrocele; operative and injection treatment, 204  
 Varicose veins and ulcers; treatment of, 386  
     clinical comparison of sclerosing solutions in injection treatment of, 389  
 Vas deferens: operative treatment, 213  
 Volvulus of right colon and Meckel's diverticulum, 705
- W**arts, moles and keloids, 137  
 Wens, 132  
 Wounds and their complications, 3  
     treatment of open infected, 11

